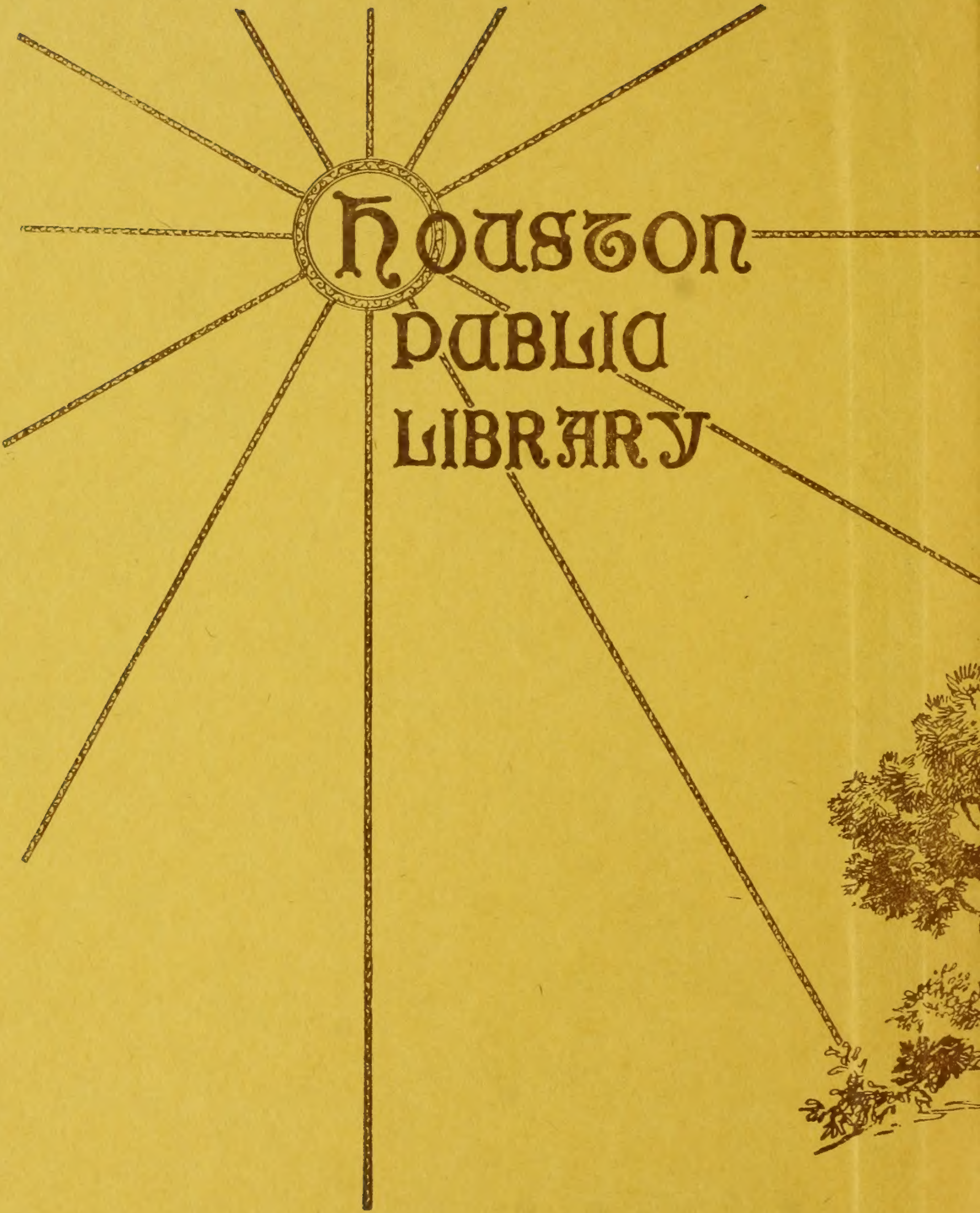

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issiles and rockets

HE WEEKLY OF SPACE SYSTEMS ENGINEERING

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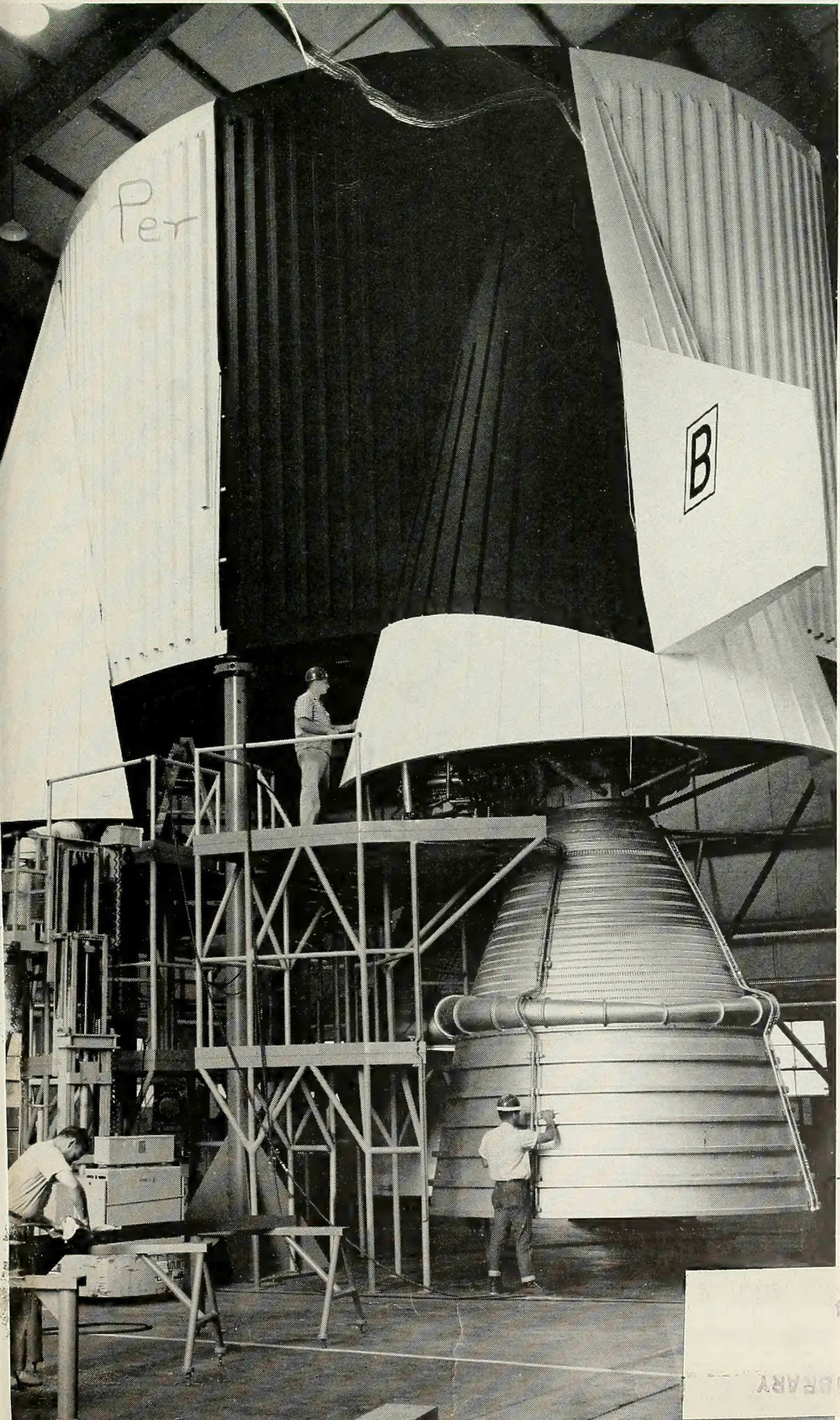


NASA Eyes H_2/Fluorine Booster Stage

Space Structure Needs for '70's

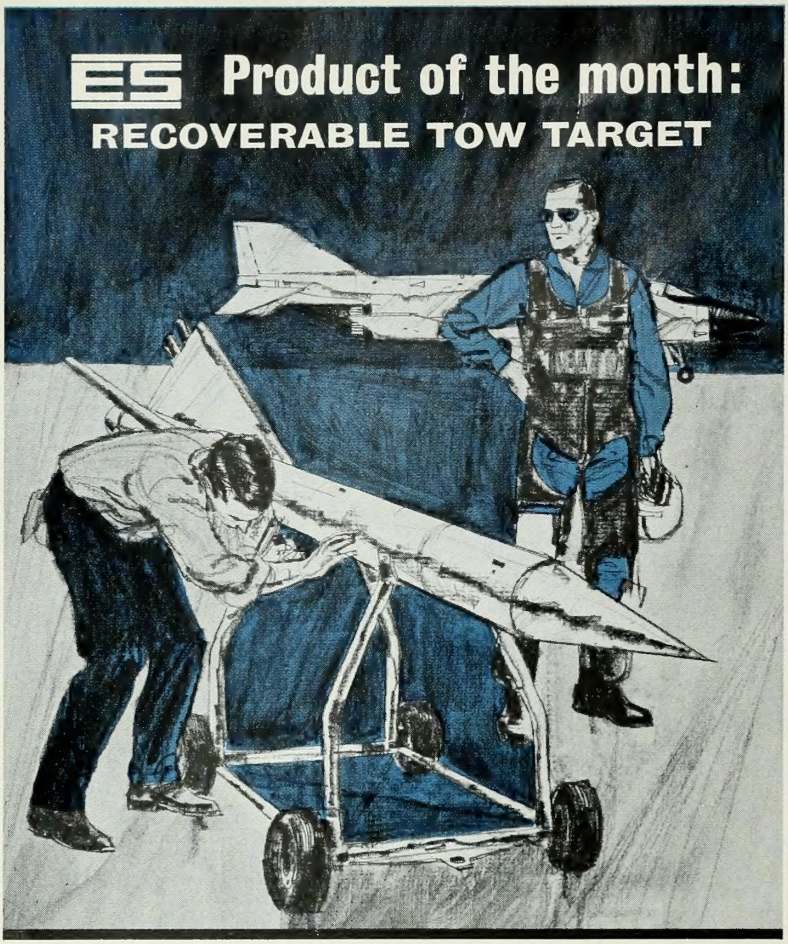
Titan II Silo Repair Time Cut

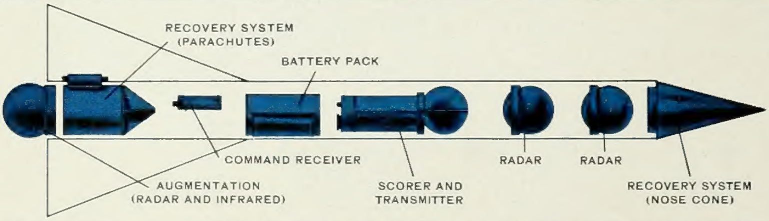
Latest Edition Of M/R Astrolog

Saturn S-IC Thrust Structure

AN AMERICAN AVIATION

ES Product of the month:
RECOVERABLE TOW TARGET




RECOVERY SYSTEM (PARACHUTES)
BATTERY PACK
COMMAND RECEIVER
RADAR
RADAR
AUGMENTATION (RADAR AND INFRARED)
SCORER AND TRANSMITTER
RECOVERY SYSTEM (NOSE CONE)

The most versatile and complete aerial tow target system in the industry—the ES-11—has just been developed by Electronic Specialty. Capable of being towed by aircraft or drone at supersonic speeds, the target is sequence-programmed upon air or ground command. The ES-11 can be recovered either by reeling into the towing vehicle or by self-contained parachute. The lightweight target system has all equipment mounted on removable trays for rapid and easy maintenance. This easy access to operating equipment permits many different missions to be accomplished by a single system merely by changing internal equipment. The ES-11 can provide both radar and infrared augmentation, and Miss Distance Indicator scoring systems may be incorporated. ECM equipment may be installed and additional power can be supplied through a wind-driven alternator. □ For complete information on the ES-11 Tow Target System, write to William Marcy, Director of Marketing, address below.

ES is a diversified, dynamic, multi-divisional organization serving defense and industry over a broad range of vital areas with advanced systems, sub-systems, and state-of-the-art components. Major contributions are currently being made in the following:

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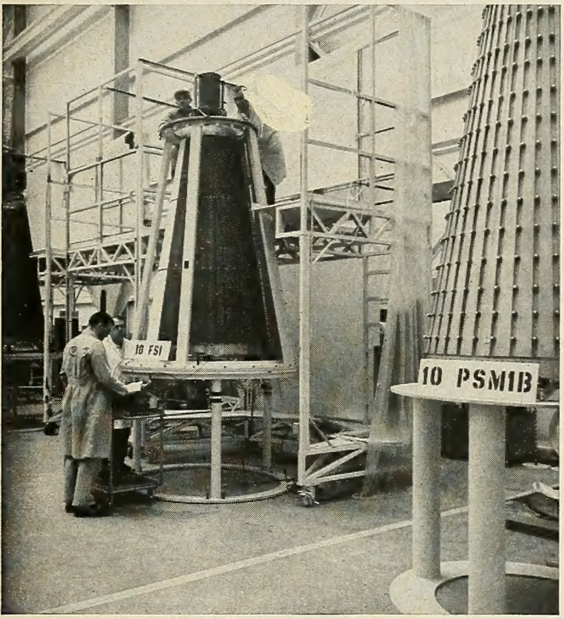

Fabrication of SNAP 10A systems at A.I.

Atomics International is a prime contractor for SNAP nuclear reactor systems for the U.S. Atomic Energy Commission. Responsibilities of the company include the entire SNAP 10A and SNAP 2 systems, as well as the reactor for SNAP 8. These power sources are designed to generate from 500 to 35,000 watts of electricity for a one-year period of unattended operation in space. Already several A.I. SNAP reactors have successfully passed their initial ground operating tests.

For the National Aeronautics and Space Administration, A.I. is studying the uses of compact nuclear power sources on the moon. To be determined: what design modifications would fit SNAP 2 and SNAP 10A for powering instruments and communications equipment on the lunar surface? Also, how could SNAP 8 be adapted to the power needs of a manned lunar base? SNAP applications might include lunar communications stations capable of operating for long periods unattended... perhaps a manned lunar experimental laboratory or astronomical observatory.

If you are interested in these and other rewarding challenges of space, the time for action is now. Opportunities now available in Atomics International's SNAP programs and other advanced nuclear work include the following:

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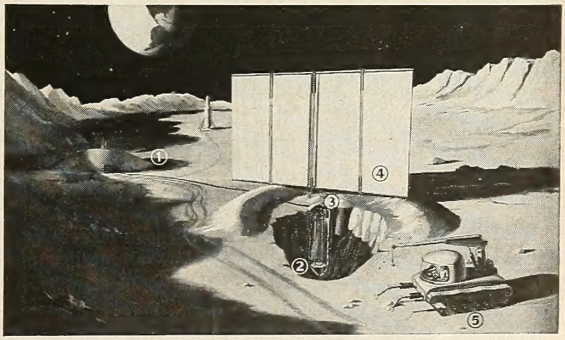
STRUCTURES — Analyze, investigate and physically test SNAP 2 radiator condensers and test fixtures to determine structural characteristics for launch loads, aerodynamic heating, shock and vibration.

DESIGN — Design high temperature, high reliability nuclear reactor auxiliary systems. Skills required in mechanical design, stress analysis and heat transfer.

Contact: Mr. H. J. Newton
Personnel Office, Atomics International
8900 De Soto Ave.
Canoga Park, California



Manned moon base illustrated at (1) would receive its power from SNAP reactor (2) beneath lunar surface. (3) shows power conversion units; (4) is radiator to dispose of excess heat. Roving electrical vehicle (5) would use SNAP power to charge its batteries.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

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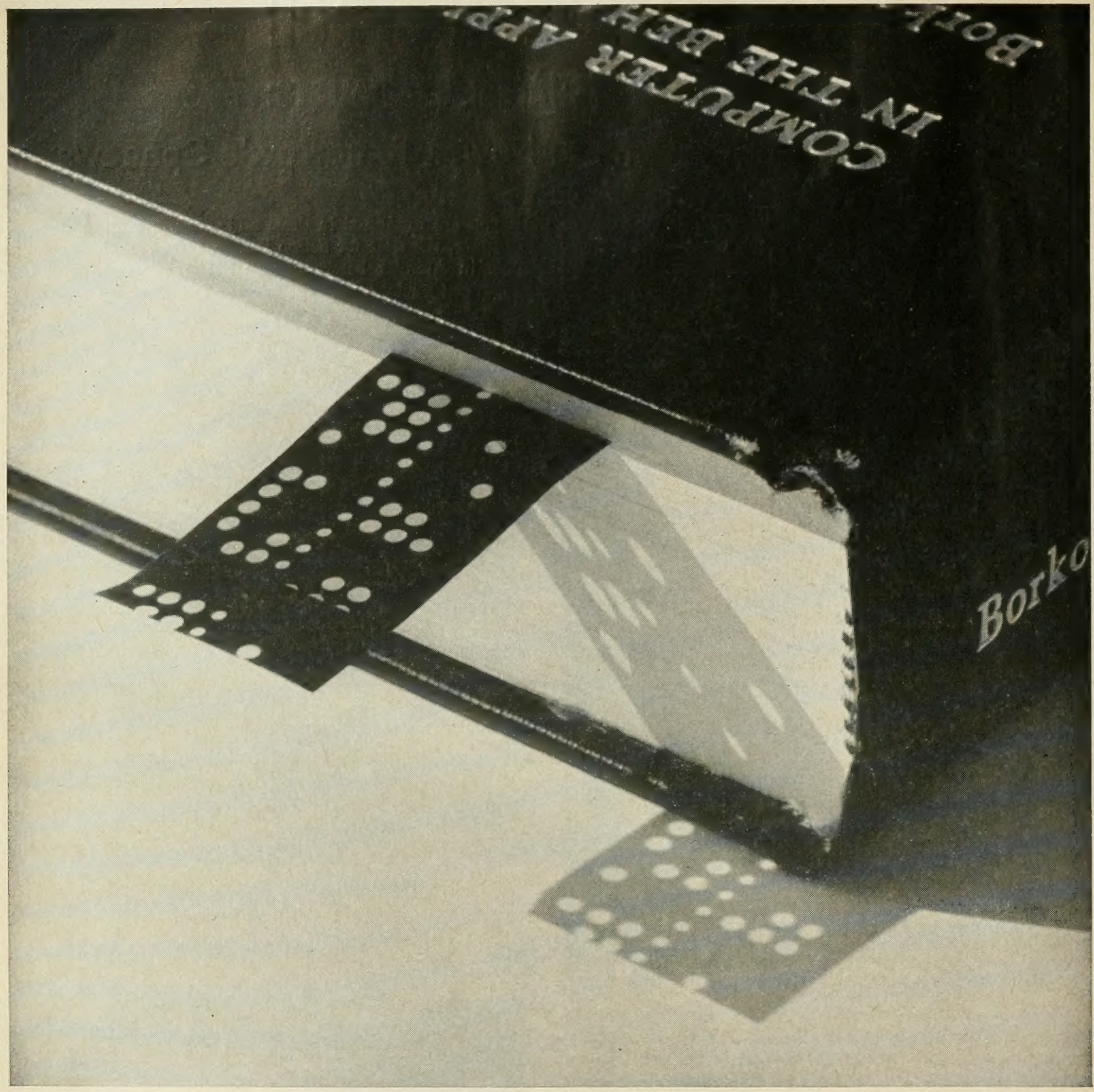

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING Volume 13, Number 10 September 2, 1963

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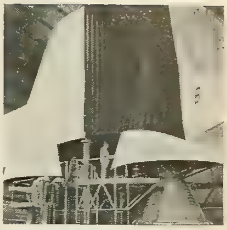

"Soft" mockup of thrust structure of S-IC stage, nearing completion at Marshall Space Flight Center, gives feel of size of overall Saturn V space booster. Two mock F-1 engines mounted beneath will be joined by three more. First ground test firing at MSFC is due in late 1964.

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45,300 copies this issue

Selling Space

To the Editor:

A few years ago public relations representatives of aerospace firms here banded together with their counterparts in the Air Force and NASA to found the Atlantic Missile Range Public Relations Association. Among our goals is one aimed at educating the public about our business (much in line with your recent editorials).

To do this we accepted an invitation this spring from the Florida Development Commission to put an exhibit in its Showcase at Rockefeller Center. It turned out to be quite a project, consuming several months and about $40,000. We raised the money by asking each member company, regardless of size, for equal contribution.

The exhibit opened June 15, intending to remain one month. However, the crowds (4,500 per day, mostly school children) broke prveious Showcase records, and the Florida Development Commission asked us to extend the stay, which we did.

The Association has been pleasantly surprised by the compliments concerning the educational value of the exhibit. It is designed to describe many of the less glamourous areas of Cape Canaveral—such as data reduction, guidance, types of propulsion, re-entry bodies, space boosters, and weapon systems.

The Association has had a few offers from groups wishing to show the exhibit before we remodel it for the Florida area of the World's Fair. However, unless groups are willing to bear the costs of transportation, insurance and maintenance, the Association, which is non-profit, just cannot afford to take advantage of these offers.

If you know of any group which might be interested in the exhibit, we would appreciate being put in touch with them.

John H. Boyd, Jr.
Director, Public Relations
Martin Co., Canaveral Div.
(Chairman, Atlantic Missile
Range Public Relations Assn.)
Cocoa Beach, Fla.

Anyone interested?—Ed.

Drones Revisited

To the Editor:

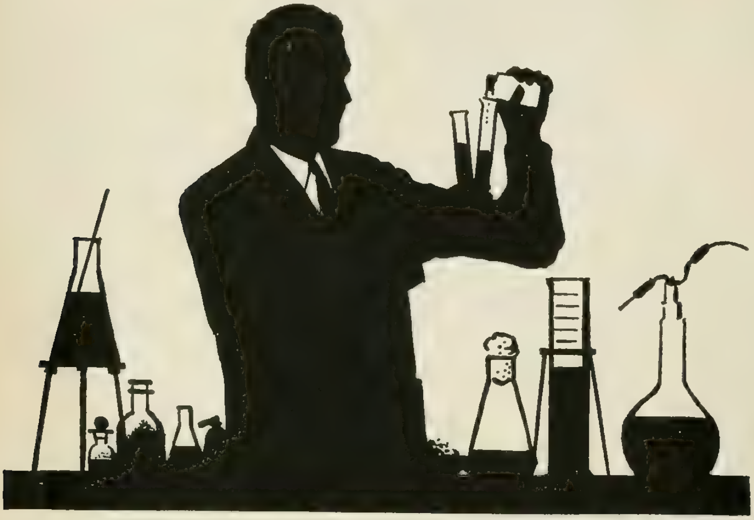
Again you and your staff have produced another outstanding edition of the Annual World Missile/Space Encyclopedia in the July 29 issue. It is superb. And, as usual, it certainly will be a handy reference tool for all of us here.

For your information, it appears that the Washington sources who supply your researchers with dope on missile target systems have again erred in some of the material on our products. Our *MQM-39A* drone, page 120, is not used by the Air Force, as stated under "remarks," but besides the Army and Navy it is used by West Germany and Switzerland. Then, on page 123, the "status" of our *AQM-37A* is that it's in *production,* not development as indicated. Also, under "support equipment," this bird is listed as "recoverable," when in fact the target is actually *expendable.* (Great for repeat business.) Also, it might be technically incorrect to call it a "drone," as the *AWM-38A's* flight profile is preprogrammed before launch and not remotely controlled.

We simply thought you'd like to have these inaccuracies brought to the attention of your people who depend on the various agencies for performance and specification data. We realize that it's generally best to use a central source for information on such a variety of systems, whenever possible, and that to double-check everything with still another source would be time-consuming and in some cases near-impossible—and still get the book out. These few errors are certainly harmless. It happens in the best of families.

Again, our compliments on a tremendous issue!

James R. Greenwood
Manager—Press Relations
Beech Aircraft Corp.
Wichita, Kan.



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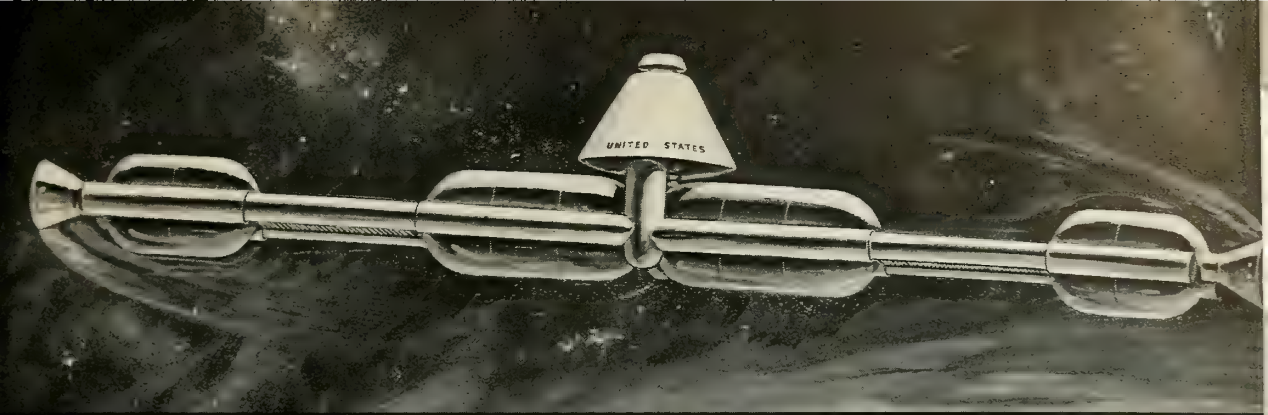
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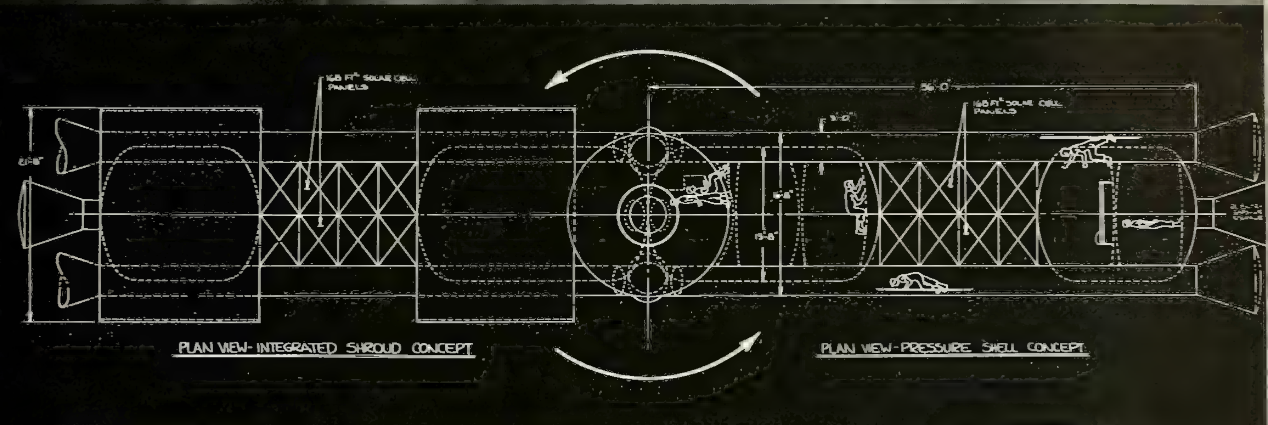
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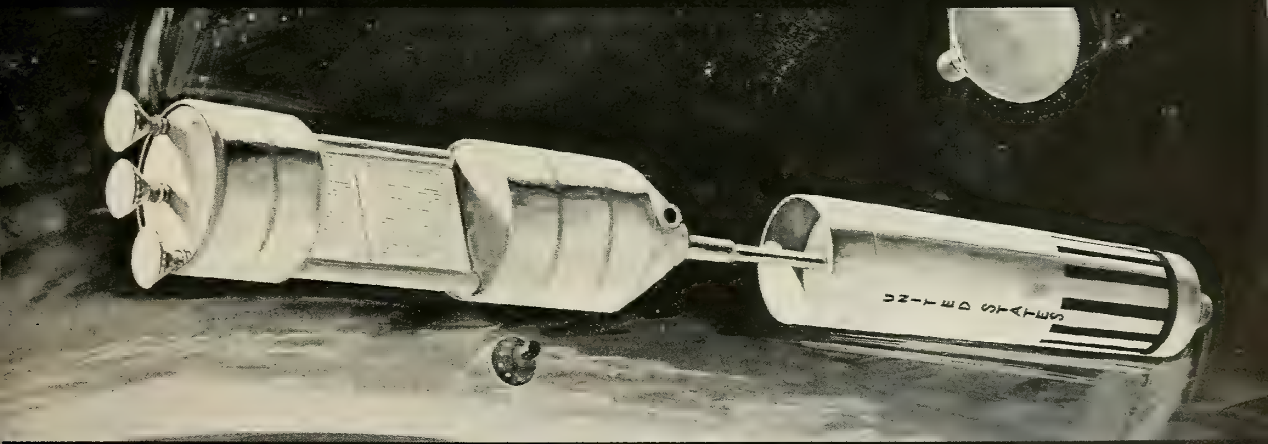
UNITED STATES

What form will the nation's first earth orbiting space station take?

Experienced Grumman design and development engineers continue to investigate all types of space station concepts —from Zero G nonrotating to rotating types. All this design effort results from the basic study of the many uses that space stations might have. As an example, earth orbiting space stations might conceivably be a twin-bladed configuration as shown above, or a multiple canister type, shown below. ■ Whatever the final design may be, the mechanical and human problems involved are enormous, demanding unique capabilities for integrating the most complex components. At Grumman, this capacity for integration is in the hands of an experienced hard core of engineers who, with free exchange of ideas in design and development, provide total systems in space technology.

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The Countdown

WASHINGTON

DOD Looks at MMRBM Substitutes

Dept. of Defense has received two proposals as alternatives to the stalled *Mobile Medium Range Ballistic Missile*. Army has proposed an improved *Pershing* with a range of as much as 800 miles contrasted to the present 400 miles. Air Force has suggested use of the two upper stages of the *Minuteman* ICBM. DOD is not showing interest in either approach.

Ranger Launch Still Slipping

Flight of *Ranger VI* now has slipped to December, with slippage into next year regarded as quite possible. This means the space agency may have time for only four *Ranger* shots before the *Surveyor* series begins early in 1965.

DOD Budget Stuck in Committee

Dept. of Defense budget, now resting in the hands of a Senate Appropriations subcommittee, has little chance of becoming law before Oct. 1. The committee appears to be holding up a decision on the need for further hearings while waiting for a number of answers DOD promised to furnish for the record. Among these: a list to be compiled by research chief Dr. Harold Brown on what R&D projects will be postponed by budget cuts, and a better explanation of why Secretary McNamara wants the wording on the *Dyna-Soar* funds changed to make it possible to spend this money on other space vehicles.

Redesign of Titan II Turbine Under Way

A Martin Co. source says the gas turbine in the engines of the *Titan II* second stage is causing the loss-of-thrust problem which has cropped up on two of the booster's development flights. Aerojet-General, engine contractor, says the problem is broader, involving the whole system. In any event, the fault has been found and the turbine is being redesigned as part of Aerojet's product development program.

Hey, Look Me Over . . .

There was a bit of irony in the Navy's announcement on Aug. 23 of two successful *Polaris* firings from the Alexander Hamilton. After a succession of *Polaris* failures two years ago, the Navy asked Dept. of Defense to clamp down on Air Force releases on the firings at sea. DOD obliged. Then came a string of Navy successes, some far beyond the sight of land, and the only way the Navy could get the word out was to leak it. Now riding a series of successes, the Navy apparently has obtained an okay to let the world know all. Question at the Cape: Will they be as frank on the failures?

Space Science Officials Journey to JPL

Most of the top officials of NASA's Office of Space Sciences journeyed to Jet Propulsion Laboratory last week to discuss the unmanned lunar and planetary spacecraft programs. Major topic: money problems forced by cuts in the space agency's Fiscal '64 authorization bill. Also open for discussion: management responsibility of future programs.

Development of SAINT Guidance Is Shelved

Continued development of guidance and rendezvous techniques for the Air Force's *Satellite Interceptor* (*SAINT*) program now is believed to have been shelved. The technology developed is being applied to NASA's *Lunar Excursion Module* (*LEM*) program. RCA's Burlington Division had responsibility in this area for *SAINT* and also has been selected for a major electronics role in *LEM*—making the transition an easy one.

New Technique Used for Titan IR Measurement

A new technique in the infrared measurement of ballistic missile trails was initiated Aug. 21 when two separate IR instrument packages were injected into the exhaust stream of a *Titan II*—one at 300,000 ft. and the other at 600,000 ft. The experiments were part of a classified measurement project—probably in the *MIDAS* development program. The 13 instruments used were designed and manufactured by Block Engineering, Cambridge, Mass.

INDUSTRY

Five Firms Bid on Surveyor Payload

Five companies—Bendix, Space-General, General Motors, American Machine & Foundry and Sperry Rand—have submitted bids for a study of a roving payload for the *Surveyor* spacecraft. RCA is said to be tied in with the General Motors bid while General Electric is on the AMF team. NASA will require about two months to evaluate bids before selecting two firms for contracts.

Pan American Officials Look Over PMR

Several officials of Pan American's Guided Missile Division at Cape Canaveral flew out for a look at Pacific Missile Range operations last week. Among them were contracting experts—giving rise to speculation that the company may be preparing to bid for range management when Air Force takes over control of PMR from the Navy (M/R, Aug. 12, p. 12). Pan Am is Atlantic Missile Range manager for Air Force.

NASA Sets Up Construction Office

NASA has established a new Office of Construction under the direction of Robert W. Long, a building contractor from Kansas City, Mo. The new office will advise key officials on adequacy of the agency's construction work and will review future plans to assure timeliness and economy.

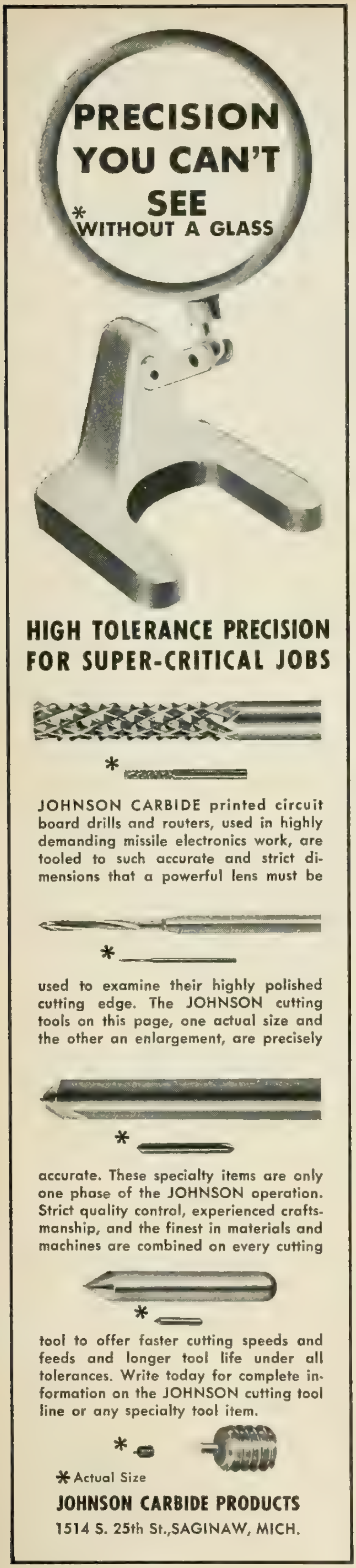
Advanced Sparrow Is Now in Production

Production of the advanced *Sparrow III* intended as primary armament for the McDonnell F4B (Navy) and F4C (Air Force) aircraft now is under way at Raytheon Co. Start of production of the improved weapon has been confirmed by the Navy.

INTERNATIONAL

French Missile/Space Industry Expands

Latest figures show that France's missile/space industry now has at least 23 firms active in the space field with more than 100 laboratories and research establishments busy on space projects. Some 13,500 people are employed in the building of missiles and space boosters.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The Missile/Space Week

Big Solids Funds Awarded

Implementation last week of two Air Force Contracts totaling $8 million came close on the heels of a DOD announcement (M/R, Aug. 26, p. 16) that it was proceeding with big solids R&D despite lack of evidence of any requirement for the motors.

Under terms of contracts announced last April, Aerojet-General Corp. gets $3 million to continue R&D work aimed at a demonstration static firing of a half-length 260-in. dia. solid motor. Work will be performed at Sacramento, Calif., and Dade County, Fla.

Thiokol Chemical Corp.'s incremental $5 million contract is for R&D leading toward demonstration static firings—presumably of both 260-in. and 156-in. motors. The Thiokol work will be done at Huntsville, Ala., and Brunswick, Ga.

DOD intends the contracts as only the first increments in a larger allocation for big solids work. Motors developed in both diameter categories ultimately are to orbit payloads up to one million pounds.

Under terms of a November 1962 NASA-DOD agreement, the space agency is conducting system application studies for potential uses for the multimillion-pound-thrust rockets.

Shots of the Week

Announcement by the Army of two *Nike-Zeus* missile intercepts highlighted an active and successful week at U.S. missile ranges.

Though actual dates of the two Western Electric *Nike-Zeus* launches were not disclosed, the announcements were made Aug. 26 and 27.

Reliable sources indicated unofficially Aug. 27 that the latter shot "followed the format" of the intercept announced Aug. 26, in which the three-stage *Zeus* hit a *Titan I*-boosted target vehicle launched on a 5,000-mile trajectory from Vandenberg AFB, Calif.

The latest test reportedly used an *Atlas* target vehicle. The *Zeus* used in the earlier shot was fired from Kwajalein Island. Components and information in the test engagements are being used in *Nike-X* development.

- The General Dynamics/Convair *Little Joe II* rocket launched Aug. 28 from White Sands Missile Range, N.M., in the first test of the *Apollo* program was termed successful by NASA. (See p. 15).
- The atomic submarine Alexander Hamilton successfully fired two Lockheed *Polaris A2* missiles Aug. 23 while submerged in the Atlantic near Cape Canaveral. The launches took place 40 minutes apart.
- A Wing II *Minuteman* launched Aug. 26 from a Cape Canaveral silo dropped a dummy warhead some 4,000 miles away in a planned mid-Atlantic target area. The Air Force said the shot had been scheduled for less than the *Minuteman's* full 6,300-mi. range.
- The Army fired a Martin *Pershing* missile Aug. 27 from a Fort Bliss, Tex., site to an impact point at White Sands Missile Range. It was the second successful White Sands *Pershing* test.
- Joseph A. Walker set a new altitude record in NASA's *X-15* Aug. 22. Walker went up 66½ miles, came back disappointed because he failed to reach the 68-mi. altitude goal set for the flight.

Propellant Mixer Explodes

A low-order explosion and fire wiped out a 300-gal. solid-propellant mixing facility at Thiokol Chemical Corp.'s Wasatch Div. Aug. 23.

The facility was under remote operation at the time, mixing a batch of *Minuteman* propellant. No personnel were involved. The explosion occurred before the addition of the curing agent, which indicates that only the mixing phase was in operation at the automated installation.

The facility was part of the Wasatch R&D section and the loss will not affect *Minuteman* first-stage production. An investigation is under way to determine what caused the mishap.

Athena Research Pushed

Ballistic Systems Div., Air Force Systems Command, hopes to cut reentry systems development to one-tenth the current cost through the Air Force Systems Command's ABRES program, and particularly the *Athena* vehicle.

ABRES (Advanced Ballistic Reentry Systems) flights began earlier this year, and are aimed at improving ballistic penetration. Their immediate goal is to determine scaling laws that will allow use of smaller payloads on the new *Athena* re-entry research vehicle flights from White Sands Missile Range, N.M.

Col. Darwin Middlekauff, director of the Ballistic Re-entry Systems Office in the Ballistic Systems Div., says the ABRES aim is to find a way to conduct re-entry research with sub-scale models.

"We'll fly identical payloads—sub-scale vehicles on *Athena* at White Sands and full-scale models on *Atlases* at AMR and PMR."

A comparison of results should yield scaling laws that will spur use of the sub-scale *Athena* payload, which is about the size of a *Minuteman* payload.

Athena is launched from a new Hanksville-Green River, Utah, installation. Payloads, propelled back into the atmosphere to simulate re-entry, impact at White Sands, 420 mi. away.

Athena development accounts for about $40 million of the $218.6 million budgeted for ABRES in FY '64. "When we develop the scaling laws," Middlekauff says, "we can cut down on the AMR and PMR full-scale flights."

BSD expects ABRES may be employed for *Atlas, Titan II* and *Minuteman,* with a selection of several re-entry vehicles to perform different missions. *Titan* systems already have been developed.

Canada Agrees on ComSats

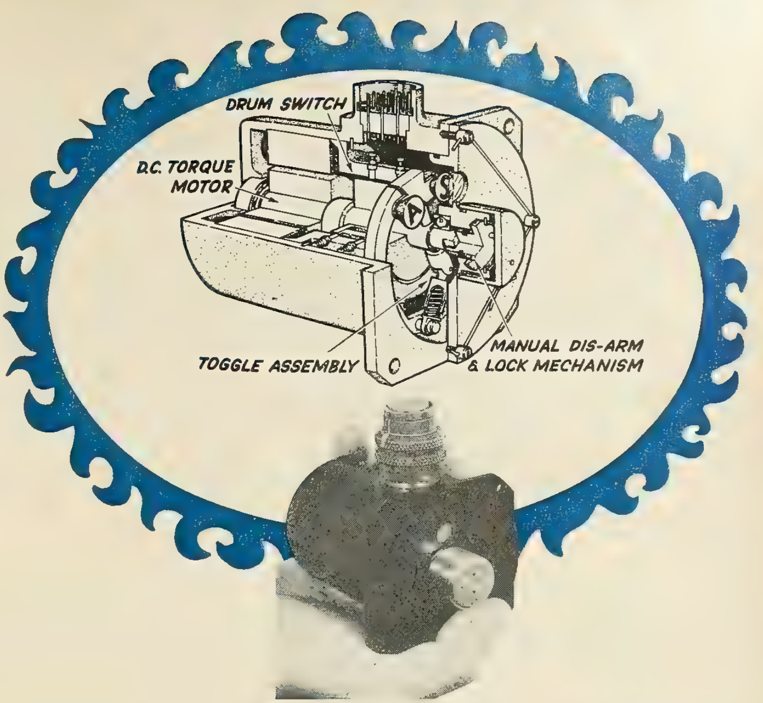
NASA and Canada's Dept. of Transport announced approval of a Memorandum of Understanding for testing experimental communications satellites launched by the space agency.

Each nation will provide a ground station to receive and transmit television and multi-channel telephone and telegraphic signals, according to the Memorandum signed in April and made operative by an exchange of notes Aug. 23.

Demonstration tests of sight and sound transmissions originating in either country and carried via a NASA satellite through communications networks of the United States and Canada will be made possible by temporary communications connections to be provided in each country as necessary, the agreement states.

Hawkins Succeeds Larsen

Willis Moore Hawkins, Jr., vice president and general manager of Lockheed Aircraft Co., will succeed



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SPACE AND INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION

Finn J. Larsen as Assistant Secretary of the Army for Research and Development.

President Kennedy last week named Hawkins to the post Larsen resigned July 31. Hawkins' appointment must be confirmed by the Senate.

Hawkins was born in Kansas City, Mo., and has held his Lockheed post since 1961.

Titan Defect Minimized

Operational readiness of the *Titan II* will not be affected by a defect in a number of the missile's 32-ft.-long second stages, say Martin Co. officials.

A Martin spokesman confirmed last week that a tiny fuel leak forced the company to recall some of the ICBM's second stages from McConnell AFB, Kan., to Martin's Denver facility.

The spokesman insisted the flaw would not change the schedule for declaring *Titan II* squadrons combat-ready. But an Air Force official said the target date for turning over missile installations in Wichita, Kan., Tucson, Ariz., and Little Rock, Ark., to the Air Force by the end of the year would not be met.

The fuel leaks were said to be "minute vapor emissions" caused by porosity of the aluminum second stage's fuel tanks.

The Martin spokesman said the leaks could not be detected even with X-ray inspection.

Glotrac at Bermuda

The final unit in the first segment of the world-wide Glotrac space-vehicle tracking system has arrived at Bermuda.

The tracking unit, housed in a 40-ft. air-conditioned van, was airlifted from the General Dynamics/Astronautics factory in San Diego to the Bermuda station.

The equipment will begin operation by mid-September.

It will work with similar mobile ground stations located at Atlantic Field in Cherry Point, N.C.; Antigua, San Salvador and Grand Turk, B.W.I. The entire network will be linked with the Azusa Mk II equipment at Cape Canaveral, which has been modified for Glotrac use.

When operational, Glotrac will be able to track spacecraft to 23,000 miles, determine velocity within six ips and location within 100 ft. through use of microwave signals sent to a transponder on the vehicle.

The Glotrac system was developed by General Dynamics/Astronautics under direction of the Air Force Missile Test Center, Patrick AFB, Fla. It was partially funded by the Pacific Missile Range, Pt. Mugu, Calif.

Planetary Landing Study Let

Avco Corp.'s Research and Advanced Development Div. will study the entry and landing of ballistic capsules on Mars and Venus under terms of an $83,000 contract from Jet Propulsion Laboratory.

Avco scientists and engineers will consider three different "families" of vehicle shapes for entry into planetary atmospheres to determine the effects of uncertainties in planetary atmospheres, aerodynamics, heat-shield materials and entry conditions.

This work is part of a NASA program in which Avco will be subcontractor to JPL. Avco is also studying the *Voyager* spacecraft and is developing the heat shield for the NASA *Apollo* spacecraft.

Injection Lasers Praised

Injection lasers will emit radiation throughout the whole spectrum between 0.84 and 3.1 microns and will be the best devices for laser communications, reports Dr. Glen Wade, assistant general manager of Raytheon's Research Division.

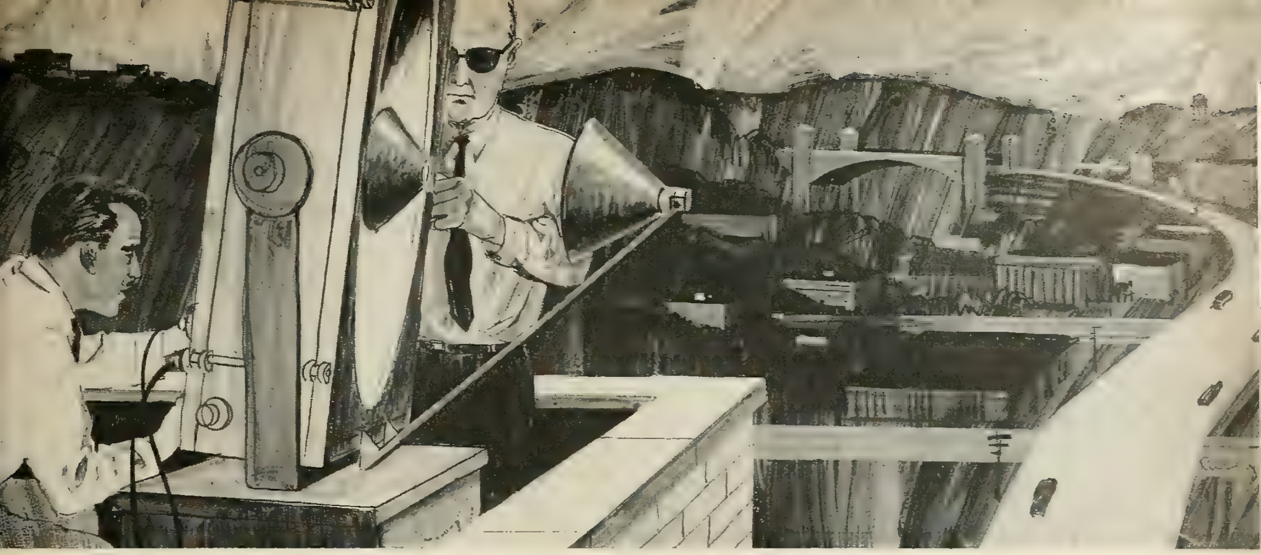
Speaking at the recent WESCON meeting on San Francisco, Wade noted that alloys of gallium arsenide and gallium phosphide at 77°K emit radiation at a wavelength between 0.63 and 0.69 microns, determined by the amount of gallium phosphide in the alloy. By mixing indium arsenide with gallium arsenide, "presumably one can extend the range of wavelengths from 3.1 to 0.84 microns," said Wade.

He pointed out further advantage—the fact that indium arsenide is tunable over a 10% band, by application of a magnetic field.

Astronaut Hopefuls Screened

Thirty astronaut candidates—selected from 273 volunteers—have received their physicals at the School of Aerospace Medicine, Brooks AFB, Tex.

The astronaut selection board, headed by Maj. Donald K. Slayton, will take them to the Manned Spacecraft Center, Houston, for interviews as soon as the board finishes study of the physical reports. Robert R. Gilruth, director of MSC, will make final selections next month.



1933 target: vehicles on a highway

1963 target: vehicles in space

Thirty years ago, Westinghouse engineers in East Pittsburgh beamed radio waves from the plant roof and detected moving autos a block away. They didn't call it "radar"—the word hadn't been invented yet.

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H_2/Fluorine Booster Stage Eyed

NASA considers fluorine first stage for future; Morrison reports on cutbacks in vehicle production

by Hal Taylor

OFFICIALS OF NASA's Office of Space Sciences—currently cutting back launch vehicle production—are giving serious consideration to a new booster utilizing a hydrogen/fluorine second stage.

They report that the 40,000-lb.-thrust stage, mated with either the *Thor* or *Titan II,* would provide a booster capable of exploring 90% of the solar system.

Further in the future, the officials would like to develop a liquid fluorine first stage—thus providing the first launch vehicle specifically designed for space science exploration.

Meanwhile, Dr. Richard B. Morrison, director of launch vehicles in the Office of Space Sciences, declared that the space agency is currently cutting production of its light and medium launch vehicles.

He told a meeting of the Orange County, Calif., chapter of the American Institute of Aeronautics and Astronautics that in the past three years the space agency has launched only one half of the payloads that it originally had scheduled. As a result, he said, NASA has had to put some ordered vehicles in storage and has slowed and cut back production by about the same percentage.

Elsewhere in his talk, Morrison said that recoverable boosters are not economically feasible in light and medium launch vehicle programs. He also revealed cost figures for the space agency's current stable of boosters.

The new stage development program is now being discussed with top officials of the Office of Space Sciences, but approval of top NASA management still has not been obtained. Informed sources report, however, that funding for the program is possible in either Fiscal 1964 or 1965.

The first step in the program has already been taken. Pratt & Whitney recently received a $900,000 contract to study the use of fluorine in its liquid hydrogen/oxygen RL-10 engine. NASA engineers indicated that using fluorine in the engine could generate the required 40,000-lb. thrust for the new stage. Whether such an approach would be feasible, they note, will depend upon the results of the study, to be completed in 1964.

- **Something new needed**—Supporters of the program say that its biggest advantage would be in cost savings. They declare that it is time to stop improvement programs and to build an entirely new vehicle.

Historically, they point out, NASA's space science program has always been forced to use in its booster programs vehicles designed primarily for missile use.

As an example, they point out that the *Delta* booster which has chalked up an amazing string of 19 successful launches uses a *Thor* missile first stage. Its second stage is borrowed from the *Vanguard* booster.

"It's worked out pretty well, but the two stages were never sized for each other," they observe. "If the stages were the right size, we could cut the dollar cost per lb. in orbit by 50%."

As far as fluorine is concerned, its use as a rocket fuel has already been extensively studied. It is now time to either use it or drop it, industry officials believe.

In addition to fluorine's greater specific impulse, another major advantage is that it has never developed the combustion instability problem which has plagued all other liquid fuels.

Combining a hydrogen/fluorine stage with a *Thor* would be the cheapest approach and would provide a payload capability of 1,500 lbs. for Earth escape and 1,800 lbs. for missions to Mars and Venus.

A *Titan II* hydrogen/fluorine booster would boost payloads of 7,000 lbs. to Earth escape and 6,500 lbs. to the planets.

In discussing the impracticality of recoverable boosters, Morrison cited the returned *Thor* missile weapon systems as a prime example. They were recently pulled out of Britain as U.S. ICBM and *Polaris* missiles took over their mission.

The space agency several months ago decided that they would not be usable in either the *Thor-Agena* or the *Delta* launch vehicles.

Morrison said that if only one in 20 of these old *Thors* was unusable, cost savings of $200,000 per bird on the other 19 would be wiped out. Another reason that NASA cannot use the old *Thors* is that such a move would force Douglas to cut by half its present production of new boosters, since NASA would have no need for them. This would then raise the cost of these boosters on the present production line.

It is also understood that actual production costs are only a small percentage of the total costs of a launch vehicle. Test and checkout, transportation and support costs provide the bigger chunk of a booster's price.

- **Cost comparison**—Dr. Morrison also gave some cost figures for NASA launch vehicles which are either being used or have a possible use in the space sciences programs. He said that cost of the vehicle per lb. of launch weight is $25 per lb. for the *Scout,* $22 for the *Delta,* $20 for the *Saturn IB,* $33 for the *Atlas-Centaur,* $31 for the *Atlas-Agena,* and $45 for the *Thor-Agena.* ■

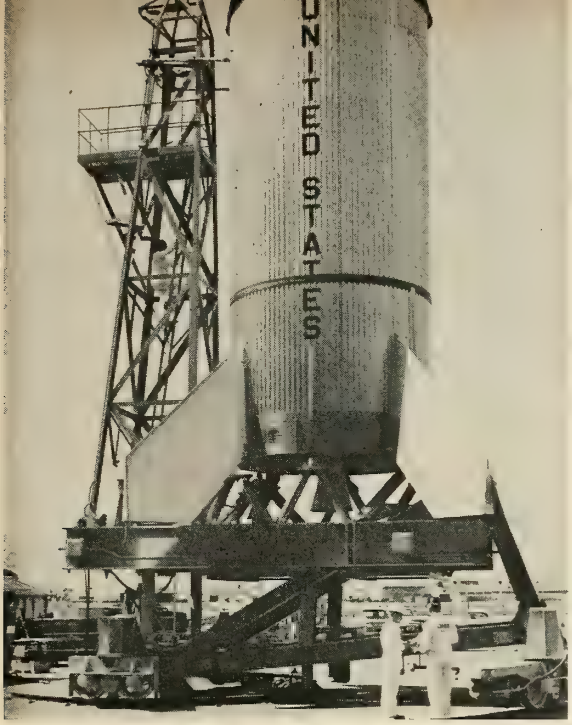
Fund Switching Curbed

HOUSE/SENATE conferees have approved new rules strongly restricting NASA's power to reprogram budget funds.

An amendment to the Fiscal '64 authorization bill stipulates that funds cannot be switched to any program whose authorization has been deleted by Congress.

Other restrictions ban reprogramming if it would increase the funding for a project over the amount authorized by Congress, or if the reprogramming would provide funds for a program never presented for Congressional approval.

NASA can reprogram in violation of the rules only if it presents the space committees of both houses a paper documenting the need for transfer of funds. If after 30 days neither committee registers disapproval, the reprogramming can be made.



LITTLE JOE II launch vehicle aft body is erected on launch pedestal.

Abort simulations first . . .

Little Joe Success Will Trigger Apollo Test Program Soon

THE SUCCESSFUL launch of the *Little Joe II* booster should make it possible to start Project *Apollo* escape system tests in about four or five weeks.

Space agency officials said the first test series would involve three flights—in which two boilerplate and one flight spacecraft would be tested under maximum aerodynamic pressures simulating off-the-pad abort during launch.

NASA announcement of the upcoming test series was made shortly after the all-solid *Little Joe II* was launched successfully Aug. 28 on a ballistic flight from White Sands Missile Range, N.M.

Only one malfunction marred the flight. A signal designed to terminate vehicle thrust was sent, but the motors did not shut down. Officials did not know the cause of the difficulty, but they said it does not appear that it will delay the testing program.

The next test will not utilize the *Little Joe II,* but will simply test the *Apollo* escape system in an off-the-pad abort. Other flights will be made later this year and early next year.

The booster—composed of one Aerojet-General Corp. Algol motor and six Thiokol Chemical Corp. Recruit motors—reached an altitude of 24,000 ft. before impacting some 9 mi. downrange.

The flight's purpose was to verify performance of the *Little Joe II* vehicle during powered flight prior to employing it to test the command module. A dummy payload simulating the size and weight of the command module and escape tower was mounted on the flight.

Officials said a final date for beginning the off-the-pad abort tests will be set following post-flight analysis of the booster.

- **Propulsion**—*Little Joe II* is 154 in. in diameter and 29 ft. high. It is made up of two sections, the upper section 19 ft. high and the lower 10 ft. high. Four 50-sq.-ft. fins are attached at the base of the vehicle.

The Aerojet-General Algol and six Thiokol Recruits generate a total thrust of 310,000 lbs. The Algol, producing 103,200 lbs. of thrust, serves as the sustaining motor and provides the primary source of thrust. The Recruits, each producing 34,460 lbs. of thrust, serve as short-duration/high-thrust booster motors to supplement the sustaining motor at launch.

The number of Algol and Recruit motors to be used in future *Little Joe II* flights will depend upon thrust requirements for each flight. Largest possible thrust is 735,000 lbs.

The electrical power supply for the vehicle instrumentation system is provided by a manually activated silver-zinc battery. Prior to launch, power is applied to the vehicle from the blockhouse via the umbilical. Switches, indicating lights and other electrical devices necessary for control and regulation of the power system, are located in the control and test consoles in the blockhouse.

Total lift-off weight of the vehicle and payload is 56,500 lbs., including 20,600 lbs. of solid propellant.

- **Payload and launcher**—The *Apollo* dummy payload is fabricated of steel. The adapter is 154 in. in diameter and 167 in. long. The simulated command module is a truncated cone 126 in. long and 154 in. in diameter at the base. The dummy escape tower is 33 ft. high.

Thus, *Little Joe II's* height including its payload is 86 ft.

The *Little Joe II* launcher is a fabricated steel structure. Its components include a pivot frame mounted on double-flange, crane-type trucks for rotation to required azimuth positions, a support platform incorporating pads and pins for vehicle support, screwjacks for tilting the support platform to required elevation angles, and a launcher mast.

The mast, attached to the support platform incorporates two stabilizing support arms for the vehicle and a support arm for the payload umbilical harness. Two A-frames are attached to the pivot frame for support of the platform hinge points. The launcher is remotely adjustable for elevation and azimuth positions. ■

Structure Problems of '70's Listed

Douglas-NASA report stresses hardening of military vehicles and missile sites, on-site vehicle building, radiation shielding

A SPECIAL NASA report has detailed the structural research problems that must be solved by U.S. industry in order to accomplish both civilian and military space missions in the 1970-80 period.

The space agency said that while primary emphasis is on the next decade, solution to the problems would be useful prior to 1970.

The report was prepared by Lewis H. Abraham, Douglas Aircraft Corp., in collaboration with the NASA Research Advisory Committee on Missile and Space Vehicle structures.

In discussing the problem areas, the report said:

—Space vehicles—it is possible to expect—will assume in the next 10 to 15 years a military role, and countermeasures will have advanced considerably. This will require hardening of space vehicles so that they can resist the effects of blast, gas clouds, particle penetration and radiation.

—Better understanding is also needed of how to achieve "effective" hardness capable of protecting missile sites from destructive weapons on the order of megatons. Conversely, the lethality of warheads will force severe technical requirements on re-entry body design.

—Mainly because of transportation difficulties, actual construction of some launch vehicles at the launch site is visualized. The facility for this could serve the multiple purpose of construction jig, test facility and launch platform. Much planning will be required to achieve this, but economic considerations will eventually dictate such a policy.

—For manned vehicles using a nuclear reactor power source, shielding weight can be reduced by providing large separation distances of possibly hundreds of feet between the reactor and the crew. Research is required in developing practical minimum weight structures that can provide this separation.

—Manned space flight beyond low Earth orbits will require shielding against ionizing radiation. Passive shielding with a large mass of material is increasingly unattractive and appears impractical. Development of active systems and associated structures will be needed if manned stations in the 1970's are to proceed without severe restriction.

—If the lunar surface is composed of thick layers of soft dust, it may be necessary to free-fall the landing module from a considerable height. This will probably require an expandable landing gear having large horizontal surface areas so as to provide stability, absorb energy, and carry impact loads to the landing vehicle.

The prediction of research requirements was based on the advisory committee's estimate of U.S. military operational missions in the 1970-80 period.

Operation of one or more large orbital space stations, with frequent travel between stations and Earth, is contemplated. These operations would include the more difficult 24-hour synchronous-type orbits, the report said.

• **Moon exploration**—By 1970, man will have initially explored the Moon's surface and will be ready for long-term exploitation of these initial explorations. The size and frequency of these operations will increase and lead

Douglas-Nord Seeks to Build SS-11 in U.S.

THE ARMY IS EVALUATING a proposal that the French *SS-11* antitank missile be built in the U.S. by a new joint company to be formed by Douglas Aircraft and Nord Aviation.

Douglas has concluded an agreement with Nord on domestic production of the missile, to be purchased in quantity by the Army. The new company would be known as Douglas-Nord.

The firm has been surveying possible sites for an assembly plant, mostly on the East Coast. Rep. Joseph W. Martin, Jr. (R-Mass.), in a letter to Donald Douglas, Jr., yesterday urged Douglas to build and test the *SS-11* in southeastern Massachusetts. Martin said excellent sites, close to shipping, roads and railroads, together with a large supply of skilled labor are available in the area, particularly around Fall River.

The Army has not yet announced whether the *SS-11* will be produced in this country. No dollar figure has been announced for purchase of the antitank weapon, although Congressional budget hearings developed the fact that Dept. of Defense had requested $45 million in the FY 1964 budget for *SS-11* and the Nord *ENTAC* missile, which the Army is buying in large quantities to replace the *SS-10*.

Licensing agreement with Nord for U.S. production of *SS-11* is held by the Army. Decision to buy the weapon on-shore probably would be followed by competitive bidding for its production. The Douglas-Nord firm could be considered to have an edge in such a competition.

SS-11 is a 63-lb. wire-guided weapon with solid propulsion and a high-explosive shaped charge. It has a length of 46 in., diameter of 6 in. and wingspan of 20 in. Range is 3,800 yds. It can be used in helicopter-to-ground missions in addition to its infantry use.

to the establishment of lunar stations in the 1970's. Lunar vehicles will be required to transport the variety of supplies necessary for maintaining a manned base and the vehicles will inevitably increase in size as fast as the advancement of the technology permits. In addition, a variety of support vehicles for lunar exploration, transportation, and construction will be developed.

Earth-launched vehicles will grow in size, and economic reasons will dictate the development of reusable types. Entry velocity into the earth's atmosphere will of necessity steadily increase, foreseeably reaching more than 50,000 ft/sec.

Manned reconnaissance, landing, exploration, and establishment of bases on the planets will be planned in the period 1970 to 1980. Manned exploration of Mars and Venus will possibly be attempted first, possibly toward the close of that decade. Planetary missions will require a complete range of vehicles for extraterrestrial atmospheric entry, landing, surface and atmospheric exploration, and launching for return to Earth.

- **Antenna requirements**—In addition, spacecraft will require certain fixed-base equipment peculiar to their specific operations. Large communication antennas that may be used on earth, on a remote planet, or even on the spacecraft itself must parallel the development of the space vehicles. Highly accurate large parabolic surfaces will be required for use on the Earth, the Moon, the planets, and in spacecraft as communication antennas, as optical and radio telescopes, or as solar energy collectors.

Turning to general research areas, the report said that many existing materials await structural application. The extraordinary properties of whiskers have not been exploited, and they still have not been incorporated into useful load-carrying structural components. Other examples include utilization of ablating thermal protection systems as structural load-carrying members. Several ablating heat-protection schemes have been used for a number of years, but as yet little use has been made of the ablating material as a load-carrying structure.

Of the unexploited metallics, beryllium, boron, and conceivably calcium appear to offer the most promise. The "apparent" potential of beryllium is yet to be realized except for some heat-sink applications. A strong effort should be made to exploit beryllium for use in primary structures, and to take advantage of its potential as a radiation shielding material and an efficient meteoroid bumper. Space vehicles appear to offer a profitable field for its use as structure.

Thermal insulation is another fertile field in materials research. Effective insulation materials are required for the temperature range of from near absolute zero to near the melting point of most refractory materials. In the low-temperature range insulation may be required to be in contact with liquid hydrogen or helium and remain reasonably flexible.

Thermal control for liquid hydrogen tanks is becoming so important that it can greatly influence the basic vehicle design. Internal insulations must remain stable and impermeable to liquid hydrogen at pressures in excess of 50 lb. per sq. in. and be sealed to prevent condensation of the surrounding air. Research is required to produce effective insulation materials and sealing methods that are effective for the thermal and mechanical strains that will be encountered.

- **Fabrication Techniques**—Orbital assembly of space stations and repair of space vehicles must be well developed by the beginning of 1970. It will be difficult, however, to provide for orbital assembly using purely mechanical attachments. Overcoming these problems will require the development of self-locking devices for remote assembly, learning of in-space welding techniques, and establishing techniques for the repair of micrometeoroid and other punctures. Self-repairing structures are highly desirable as a protection against the micrometeoroid hazard. Self-sealing liners for space structures is one approach. Provision for easy movement of equipment inside the space vehicle and rapid access to the damaged areas for repair is also necessary.

In-flight repair techniques, automatic or manual, will certainly be required for space missions of long duration. Methods must be developed to replace and repair expendable or damaged elements of spacecraft structure. Punctures, cracks and leaks must be detected and arrested before they grow to catastrophic proportions. Ablation-type heat shield and impact absorption landing systems must be capable of being replaced or refurbished before each mission and may require attention immediately prior to re-entry to eliminate any damage that may have occurred in space.

"Canning" of fuel elements into desirable configurations offers a challenge to the missile/space industry. Fuel elements for advance nuclear rockets must be made of refractory materials built into desirable configurations and loaded with a nuclear fuel. For heat-transfer purposes, special configurations such as honeycombs or concentric rings are desirable. Tungsten is one of the most promising canning materials for use in fuel elements; however, much forming and joining research is needed before this material can be used satisfactorily in this application.

Research is being directed toward gaseous cavity reactors for nuclear rockets. Pressure in the cavity may be in hundreds of atmospheres and temperatures in excess of 10,000°F may be experienced in this device. The feasibility of this concept depends on the solution of the materials application and structural design concepts for nozzles and reactor containers. ■

Joint, DOD-Managed Ship Pool Ordered

Congress has told NASA and DOD to develop by January a plan for a joint fleet of ocean tracking vessels.

Legislators have also ordered a study of ocean tracking needs, particularly the complex requirements of the future *Apollo* Moon program. A *House* report on a conference meeting termed "senseless" a proposal for separate ship operations. A NASA request for $90 million for three *Apollo* tracking vessels of its own was cut to $83.3 million in conference, and NASA was told not to commit any authorized funds for tracking ships until the study and interagency agreement are completed.

Congress also made it clear that DOD would have the job of scheduling, navigation, operation and maintenance of the tracking ship pool.

Pentagon observers said that NASA earlier had been asked to present its tracking needs to DOD, which sent back a plan. They said the House Aeronautics and Space Committee apparently decided the Pentagon plan should be adopted.

The House version in the Congressional Record of the conference, which reached accord on the NASA 1964 request Aug. 23, said that "insufficient attention has been paid to the total national needs for tracking and communication for space missions."

The House trimmed the $90-million NASA request for tracking ships to $80 milllion, while the Senate left it at $89 million. The plan Congress has ordered must cause "no delay in the *Apollo* program," the report said.

The current instrumented fleet includes 17 vessels on the Atlantic and Pacific missile ranges.

During budget review . . .

Surveyor Orbiter RFP's Expected Next Month

NASA IS EXPECTED to be ready to issue requests for proposals for the *Surveyor Orbiter* satellite sometime next month.

The decision will be made during a budget review at NASA headquarters. The $20 million Congress left of the $28 million requested by the agency is expected to be sufficient to allow the project to proceed with only a slight delay in flight plans.

Scheduled launch, if the $20 million survives the appropriations committees' action, will be sometime in the latter half of 1965 or early 1966. The spacecraft is to be launched with an *Atlas-Agena,* and has been scaled down from an earlier, heavier version employing an *Atlas-Centaur.*

The satellite is designed to do one or more of the following: photograph areas where *Ranger* or a *Surveyor* has landed; search for landing spots for *Surveyor,* measure the lunar gravity constants, and determine the radioactivity; photograph 150 selected strips on the Moon measuring ¾ by 20 miles; or survey the entire area in which men are interested, with a 75-ft. resolution.

• **Other budget action**—Budget hearings have been concluded in the House Appropriations Committee, but a bill is not expected to emerge for several weeks since the committee treats all the independent offices (NASA, FAA, etc.) in one package.

Senate Appropriations hearings have not been held yet, because members have been occupied with other legislative business. As with the authorization, the traditional pattern is for the House to cut, the Senate to restore part, and the conference to split the difference.

The authorization, which sets the ceiling for appropriations, has come out of the House-Senate conference with $362 million cut from the NASA request of $5.7 billion. Thus, NASA will have a maximum of $5.35 billion in FY 1964 (M/R, Aug. 12, p. 13).

As predicted, the conferees split the more-than-$300-million difference in the two bills, the final amount being $161 million less than the Senate version, and $147 million more than the House approved. The main compromises were:

—*Manned spaceflight*—The $120 million cut by the House was split in half, bringing the total budget to $1.497 billion. Launch vehicle and propulsion systems, cut $30 million by the House and $15 million by the Senate, ended up with a compromise $21-million cut. Integration and checkout funds remained at the House level, with $28 million cut.

—*Communications satellites*—The House again had its way and persuaded the Senate conferees to go along with a $9-million cut. The Senate had deleted only $7 million.

—*Geophysics and astronomy*—The follow-on international studies, amounting to $4 million, which the House had cut in entirety, were restored by the Senate and by the conferees.

—*Lunar and planetary exploration*—$28 million in funds for *Surveyor Orbiter,* deleted by the House and fully restored by the Senate, finally emerged from the joint committee at $20 million.

—*Facility, training and research grants*—The House and Senate split the difference in the two bills almost equally, bring the total to $40 million instead of the $30.6 million and $50 million in their respective measures.

—*Nuclear rocket program*—Cut $5 million by the House and fully funded by the Senate, the final amount fell $2.5 million below NASA's $96.7-million request.

—*Tracking and data acquisition*—The $15 million cut by the House and the $11 million cut by the Senate were brought to a compromise $13-million cut. The instrumentation ships, cut $10 million by the House and only $1 million by the Senate, received funds for almost $7 million below the requested $90 million.

—*Boston Electronics Center*—The House held to its requirement that NASA must justify need, location and other factors pertaining to the construction of an electronics research center in Boston. If the center is justified in the eyes of Congress early next year, it will receive only $3.9 million of the $5 million requested for 1964.

Other facilities: Below is the disposition of other construction funds (in millions):

	Request	**House**	**Senate**	**Final**
Flight Research Center	$ 4	$ 0	$ 1.16	$ 1.16
Goddard	20.9	17	20.3	17
Launch Operations	312.9	279.7	300.3	284.9
Mississippi Test	111.7	92.7	102.2	100.1
LEM Test facility	15	11.5	14.5	14.5
Manned space flight data acquisition and tracking	21	14.5	21	19.5
Wallops Station	2	0	.5	.5
Facility planning and design	10	15	25	20

House Establishes New R&D Subcommittee

THE ENTIRE SPECTRUM of the nation's scientific research and development will soon be scrutinized in hearings before a new R&D subcommittee of the House Science and Astronautics Committee.

The new subcommittee, to be chaired by Rep. Emilio Q. Daddario (D-Conn.) reflects a general Congressional feeling that the government's vast research program is not getting proper supervision by the legislative branch (M/R, Aug. 19, p. 15). It also is an apparent effort by the Space Committee to stave off the creation of another Congressional committee to probe all R&D.

The subcommittee has the specific tasks of: 1) overall evaluation of scientific research and development, 2) strengthening of Congressional information and advice on the field, 3) work toward achieving the most effective utilization of the scientific and engineering resources to accomplish national goals, and 4) Congressional oversight of the National Science Foundation.

Rep. Daddario is known for his close surveillance of areas of duplication and waste in NASA and DOD, and for his work as chairman of the Space committee's panel on patents and scientific inventions.

ASTROLOG

Current status of U. S. missile and space programs

Missiles

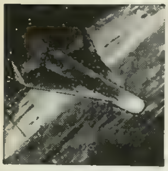
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime	ASW surface-to-underwater; weight—500 lbs.; solid; HE depth charge; free-flight rocket; range 900 yds.	Operational; deployed on destroyers and cruisers
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control	ASW surface-to-underwater; solid; nuclear or conventional warhead, range between 1800 yds. and 8 miles; weight: 1000 lbs.; unguided	Operational on DE, DD, DLG, & heavy cruisers. Advanced ASROC being developed; one "live" weapon fired in Pacific nuclear tests
ASTOR (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional; range, about 11 n. m.; solid	In production; to be deployed on hunter-killer submarines
ATLAS (Air Force)	STL, systems engineering & technical direction; GD/Astronautics, frame; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series inertial guidance; ATLAS "D" radio inertial	13 squadrons operational at 11 bases; total no. of missiles: 129; phaseout to begin soon; ATLAS Standard Launch Vehicle being developed for AF space programs; 5-engine model proposed
BOMARC (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 n. m. range; Mach 2.5; nuclear; ceiling, over 68,000	Five bases operational in northeastern U.S.; production completed; costs $20 million per year to operate system
BOMARC B (Air Force)	Boeing, prime; Gen. Precision Aerospace/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 n. m. range; nuclear	First base operational May, 1961; two more planned; production completed
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol/Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-link command guidance (visual reference); conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and one pre-packaged liquid motor; nuclear-tipped	Deployed with Atlantic and Pacific Fleets, operational with Air Force units; new training version under development, as TGAM-83 replacement
CORPORAL (Army)	Firestone, prime; Gilfillan Bros., Inc., guidance; Ryan, propulsion	Surface-to-surface; 75 n. m. range; liquid; nuclear; pre-set & command guidance	Deployed in Europe. SERGEANT replacing CORPORAL
DAVY CROCKETT M-388 (Army)	In-house project directed by Army Weapons Command at Rock Island, Ill.	Surface to surface; solid; bazooka-launched; sub-kiloton nuclear warhead; two launchers: vehicle-mounted or carried by two men	Operational in Europe; $13 million provided in FY '64 budget; 20 per division; seen as defensive rather than offensive weapon to prevent overrun of Europe
ENTAC (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; solid; shaped charge HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
AADS-70 (Army)	Hughes, Raytheon, RCA—feasibility studies	Field army ballistic missile defense system, mobile	Expected to be operational in 1970's
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion; Lockheed Propulsion, AIM-47 propulsion	Air-to-air; 5 n. mi. range; supersonic; solid; conventional; AIM-4A, and 4E, active radar homing guidance; AIM-4B, 4-C, 4-D, and 4-F, IR homing; AIM-26 model has nuclear warhead and hybrid IR radar homing	Operational; buy-out of 4E, 4F and 26 in FY '62; AIM-47 under minimum effort development
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 6-mile range; nuclear; solid rocket; supersonic; proximity fuzing	Operational on F-101B & F-106; improved version cancelled
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; 100-45,000 ft. ceiling; launch wt., 1275 lbs.; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); bought by Sweden and Israel; advanced HAWK being funded at $25.9 million for R&D as antimissile weapon

★ Indicates changes since July 1963 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HONEST JOHN M-50 (Army)	Douglas/Emerson Electric, prime· Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5900 lbs.; ADVANCED HONEST JOHN also being developed	Operational; deployed in Europe; to be replaced by LANCE
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface standoff missile; about 600 n.-mi. range; Mach 2+; turbojet nuclear B version in production, ceiling in excess of 50,000 ft.	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400 to compensate for SKYBOLT cancellation
JUPITER (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; range over 1500 mi.; guidance; all-inertial	Being withdrawn from operation; replaced by POLARIS; future of missiles being studied
LACROSSE (Army)	Martin, prime; Martin/Federal Div. ITT, guidance; Thiokol, propulsion	Surface-to-surface; mobile; command guidance; 20-mile range; solid; nuclear	Operational; three units in Europe; eight activated; to be replaced by LANCE
LANCE (Army) (Formerly designated MISSILE B)	Chance Vought Div., Ling-Temco-Vought, prime; Systron-Donner, AUTOMET guidance	A highly mobile general-purpose missile; range 3-30 miles; Automet guidance; one missile per launcher; nuclear and conventional warhead; pre-packaged storable propellants	Large-scale development; eventually will replace HONEST JOHN and LACROSSE; division support weapon; to use multi-system test equipment
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands	Two battalions activated in '61; each equipped with four launchers; air and helicopter transportable; may be replaced by LANCE
M72 (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; range 500 yd.; earlier called LAW	Operational
MACE (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet and solid; nuclear; B model: 1200-mile range; inertial guidance	Five MACE-A and one MACE-B squadron deployed in Europe; two MACE-B squadrons on Okinawa in hard sites
MATADOR (Air Force)	Martin, prime; Air Force, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 500 mile range; speed, about 650 mph; ceiling above 35,000 ft.	Being turned over to West Germans; also deployed in Korea and on Taiwan
MAULER (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; deHavilland, IR acquisition; Raytheon, radar; Burroughs, computer; FMC, vehicle	Surface-to-air; IR acquisition; solid; weight, 120 lbs.; highly mobile antiaircraft and antimissile missile; tracked vehicle; 9 per launcher rack	Development; NATO may buy; Navy planning SEA MAULER; to use multi-system test equipment; FY '64 request is $83.3 million; usable against short-range tactical missiles
★**MOBILE MEDIUM-RANGE BALLISTIC MISSILE** (Air Force)	Program Definition Phase: Hughes & Northrop, integration, assembly and checkout; Ford Aeronutronic/Fairchild Stratos & Sperry Rand, re-entry system; Thiokol, propulsion; Goodyear Aircraft, transporter-launcher-erector; Hughes and Martin in association with Sylvania, command and control; General Precision, guidance	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Continued development of guidance, control systems; no decision yet on production or deployment
★**MINUTEMAN** (Air Force)	STL, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules third stage; Avco, re-entry vehicle	2nd-generation ICBM; solid; deployed in hardened and dispersed silos; 32 sec. reaction time; nuclear; 3 stages; range: over 5000 miles; guidance, all-inertial; target selected in seconds; advanced MINUTEMAN with greater range-payload and new re-entry vehicle under development	Development; 150 now operational at Malmstrom, Mont.; later at Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D., Grand Forks, N. D.; 950 missiles through FY '64; eventual force size may be 1300; advanced version to be fired from airborne command posts; expected operational 1965-66
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; ceiling, in excess of 150,000 ft.; solid; command guidance; Mach 3+; nuclear or conventional; antiaircraft, tactical missiles; weight, 10,000 lbs.	Over 80 batteries deployed in U.S.; over 10 N-H batteries deployed overseas. To be equipped with HIPAR, a high power acquisition radar, and anti-tactical-ballistic-missile capabilities
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Antimissile missile; 3-stage; 200-mile range; solid; nuclear; command guidance; weight, 22,800 lbs.; length, 48 ft.; diameter, 36 in.; fin span, 10 ft.	Downgraded in favor of NIKE-X; continued development planned; funded for $89 million in FY '64; eight successful intercepts
NIKE-X (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin-Marietta, SPRINT missile prime; Hercules Powder Co., and Lockheed Propulsion Co., SPRINT propulsion	Most advanced portion of NIKE-ZEUS concept; uses a mix of ZEUS/SPRINT missiles and multi-function array radar (MAR)	Engineering development; funded for $246 million on accelerated development schedule, but deployment still deferred; more effective than NIKE-ZEUS
★**PERSHING** (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; inertial guidance; approx. 400 n. mile range; nuclear; transported on FMC XM474 tracked vehicle; to replace REDSTONE	Flight test program, including shots from Utah to New Mexico scheduled for September, nearly complete; first tactical equipment delivered to troops in December, 1962; West Germany buying

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
PHOENIX (Navy)	Hughes Aircraft Co.	Air-to-air missile for use with the TFX fighter aircraft	Development; HAC has $12.2-million contract
★POLARIS (Navy)	Lockheed, prime; GE/MIT/Hughes, Minneapolis-Honeywell, Raytheon, guidance and fire control; Aerojet-General, Hercules, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training; Systron-Donner, ignition programing	Underwater and surface-to-surface; solid; 1200-n.-mi. range; A-1 aboard first five submarines; nuclear; A-2 (1500 n.-mi.) aboard submarines 6-17; A-3 (2500 n.-mi.) aboard 18th and subsequent subs; all subs to get A-3 eventually; Total authorized POLARIS submarine program: 41	Nine subs each with 16 missiles operational; A-2 operational; A-3 in 1964; 23 A-3 flight tests have been conducted; 13 fully successful; deployed in Atlantic and Mediterranean; Pacific servicing facilities being built; British to buy missiles from U.S.
QUAIL (Air Force)	McDonnell, prime; Guidance Technology, Inc., guidance; GE, propulsion; Thompson Ramo Wooldridge, ECM equipment	ECM-carrying decoy; about 200 m. range; turbojet powered advanced version with 400 mile range has been flight tested	Deployed at SAC bases; carried by B-52; procurement completed FY '61
REDEYE (Army)	GD/Pomona, prime; Philco, IR seeker; Atlantic Research, propulsion	Surface-to-air; 4 foot, 22-lb. bazooka-type; IR homing guidance; solid; conventional; length, 44 in.; diameter, 2.75 in.	Development; no procurement funds in FY '64 budget due to development problems resulting in two-year slippage
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; inertial guidance; nuclear	Deployed in Europe; being replaced by PERSHING
REGULUS I SSM-N-8 (Navy)	Ling-Temco-Vought, prime; Sperry, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet and solid; 500-n.-mi. range; speed, about 600 mph; ceiling, approx. 40,000 ft.; nuclear	Deployed aboard 2 cruisers; phaseout of 5 Regulus subs to start this year; KDU-1: drone version; missiles retrofitted with airborne guidance
SERGEANT (Army)	Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; over 75 n. mi. range; nuclear; inertial guidance uses drag brakes; 10,000 lbs.	Production; major procurement to be completed during FY '63; replacing CORPORAL; West Germany buying and has activated one battalion
SHILLELAGH (Army)	Ford Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance	Surface-to-surface; lightweight; vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development; testing at White Sands; to use multi-system test equipment; engineering development stage begins in FY '64; to be installed on Gen. Sheridan assault vehicle
SHRIKE (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; guidance, passive radar homing; solid motor; formerly ARM	Development; first production buy in FY '63; AF plans to buy it during FY '64
★SIDEWINDER (Navy-Air Force)	GE-Philco, prime; Philco/GE, guidance; Naval Propellant Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; 1-C models: switchable IR and radar-guided warheads; improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version started in 1962; NATO-built version now in production
★SLAM (Air Force)	Ling-Temco-Vought, nuclear vehicle components; AEC, Marquardt, propulsion	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph	Propulsion system being developed under project PLUTO; feasibility proven by TORY reactor tests
★SPARROW III AAM-N-6A (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Air-to-air 5-8 mile range; Mach 2.5-3; ceiling, over 50,000 ft.; semi-active, CW homing, guidance; solid; conventional	Operational with carrier aircraft; production begun on advanced version (SPARROW III B) prime armament for F4H-1 and F3H-2 interceptor; SPARROW III and III A in use; production begun on advanced version as prime armament for F4B and F4C interceptors
★SPRINT (Army)	Martin-Orlando, prime; Hercules Powder and Lockheed Propulsion Co., propulsion; Bell Telephone Laboratories, guidance	High-acceleration missile for low-altitude interception of ballistic missiles; to be part of the missile mix in a NIKE-X battery	Development; studies submitted by Douglas, Martin and North American
★SUBROC (Navy)	Goodyear, prime; Gen. Precision/Aerospace, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater-surface-underwater antisubmarine missile; 25-30 mile range; solid; nuclear	R&D; scheduled for installation in Thresher class subs; reportedly entire system was tested in nuclear tests
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; antitank; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units and Army helicopters
★TALOS (Navy)	Vitro, systems engineering; Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Sperry, guidance; GE, launching gear	Ship-to-air; 65-mile range; solid and ramjet; Mach 2.5; nuclear; radar beam riding/semi-active homing guidance	Operational aboard cruisers Galveston, Oklahoma City and three heavy cruisers; Long Beach, nuclear-powered cruiser, has advanced TALOS
★TARTAR (Navy)	Vitro, systems engineering; GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion; Northern Ordnance, launching gear	Ship-to-air; 10-mile range; Mach 2; beam-riding guidance; solid dual-thrust motor; conventional	Operational; installed aboard 15 guided missile destroyers and cruisers equipped with TALOS
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
★TERRIER/ADVANCED TERRIER (Navy)	Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; ABL, propulsion; Northern Ordnance, launching gear	Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional; 2 advanced versions operational	Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle; Thiokol, solid rockets for added thrust	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear; guidance, all-inertial; used extensively as space booster	Phaseout; 15 missiles to be converted by Douglas for space boosters; some vehicles "souped up" by adding solid rockets for DISCOVERER program
TITAN (Air Force)	STL, systems engineering & technical direction; Martin, prime; Bell/Sperry, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	ICBM; 5000-mile range, LOX/RP-1 fueled; 90 ft. long; 2 stages	Operational; 54 missiles at 5 bases
★**TITAN II** (Air Force)	STL, system engineering and technical direction; Martin, prime; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle	ICBM; over 5000-mile range; N_2O_4 & Aerozine-50 storable fuels; 115 ft. long; 2 stages; greatest payload & range of any U.S. ICBM; basic core vehicle for TITAN III	One squadron operational at Davis-Monthan AFB; some trouble experienced with second stage and with vibration in GEMINI booster version; overall performance high
TOW (Army)	Hughes, prime	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC
★**TYPHON** (Navy)	Bendix, GD/Pomona, missile and missile electronics; Westinghouse, weapons direction system and radar; McDonnell, propulsion; Northern Ordnance, launching gear	Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets	Development; successor for TALOS, TARTAR and TERRIER. System is encountering development problems and deployment will await extensive testing
WALLEYE (Navy)	NOTS-China Lake	Air-to-surface 1000-lb. glide bomb with homing guidance, no propulsion; powerful conventional warhead	Development; Navy says it will be the "most accurate and effective air-to-surface conventional weapon ever developed anywhere."
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	5-inch, air-to-surface; solid; unguided; 5 n.-mi. range; conventional	Operational; designed for use on jet fighter and attack aircraft



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ANNA (NASA)	Bureau of Naval Weapons/Applied Physics Lab, prime; AF Cambridge Research Laboratories/Edgerton, Germeshausen & Grier, flash tube experiment; Army Engineers/Cubic Corp., CW transmitter	Geodetic satellite; 600-mi. orbit; 36-in. aluminum sphere (with solar cell belt, 48 in.); weighs 355 lbs.; boosted by DELTA	Development; first launch failed May 10; second launch successful in November. Program now under NASA management. NASA to launch one satellite per year beginning in 1964
★**APOLLO** (NASA)	North American, Command & Mission Modules, systems integration; Grumman Lunar Excursion Module (LEM); MIT, guidance development; Collins Radio, telecommunications; Minneapolis-Honeywell, stabilization & control; AiResearch, environmental control; Radioplane, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN I and SATURN IB for earth orbits; SATURN V for lunar rendezvous; 3-modular spacecraft: command module, 5 tons; service module, 23 tons; lunar excursion vehicle, 15 tons; total weight: 85,000 lbs.	Earth orbital shots scheduled 1964-65; lunar orbits 1967; lunar landing 1968
ARENTS (ARPA)	GD/Astronautics, prime	Series of three satellites to investigate space environment of 22,000 mi. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload; program re-evaluated due to CENTAUR delay
AEROSPACE PLANE (AF-NASA)	No contracts announced	Manned, hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, 0-3 Mach; ramjet, 3-8 or 10 Mach (oxygen collected and liquified during this cycle); 8 to 10 Mach-orbital speeds, LH_2-LOX rocket	Joint NASA-AF research program approved. NASA funding $4 million in FY '64
ASSET (Air Force)	McDonnell Aircraft Corp., prime; Minneapolis-Honeywell, guidance	Aerothermodynamic elastic Structural Systems Environmental Tests for various materials combinations during re-entry; two versions planned, 1100 lbs. (4) and 1200 lbs. (2). Strongly resembles X-20. Length. 68.7 in.; span: 58.9 in.	Development; six vehicles to be built & launched with THOR and THOR-DELTA boosters at AMR beginning this summer. Designed to obtain same general type of aerodynamic research information as X-20
BAMBI (ARPA)	Studies: GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost using space based platforms and interceptors	Feasibility still not proved; additional research under way
★**BIOS** (NASA)	GE, prime	1,000-lb. recoverable capsules with primates aboard; capable of orbital flights up to 30 days. Flights to begin 1965. Will be launched by THRUST-AUGMENTED DELTA	Six flight models to be built. First flight in 1965. Others to follow at three-month intervals

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE (AF-DCA-Army)	GE, Philco-STL; definition studies under evaluation	Multiple-launch, active repeater ComSat; 24-36 satellites in 5000-12,000 naut. mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster	One of two systems resulting from re-oriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966
COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	24-hour, station-keeping, active repeater ComSat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA	Second system evolved from ADVENT; initial capability, 1964; operational, 1966
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program
★DYNA-SOAR (X-20) (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link; Sundstrand, auxiliary power; Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system. Project ASSET, McDonnell	Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	Development; funded at $125 million in FY '64; manned orbital flight planned after drop tests
★ECHO (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 700-to 805-mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital	ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful. Orbital launch from PMR planned late 1963
★GEMINI (NASA)	McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Minneapolis-Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENA will be used for rendezvous missions. 15 spacecraft will be produced	Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, early 1964. Manned and rendezvous flights, 1964-65; AF participation in program has been approved; this could add 4 to 6 more spacecraft to the program
INTERPLANETARY MONITORING PLATFORM (NASA)	Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit	125-lb. satellite launched into deep-space orbit with an apogee of 172,000 miles. It will measure radiation and solar flares in advance of Project APOLLO hazard. Launched by DELTA booster from AMR	Program calls for eight satellites. Launches will begin late 1963. Later flights will use a nuclear power unit as replacement for solar cells
LUNAR LOGISTICS VEHICLE (NASA)	Three-month study contracts awarded to Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp.	Spacecraft to carry support payloads to the Moon. Two designs under study, LEM Truck and logistics spacecraft with 25,000-to-30,000-lb. payload	Program decision expected late 1963, with two-year delay expected in development; program would cost about $1 billion
★MANNED ORBITING SPACE STATION	Boeing, Douglas and Lockheed; NASA study contracts	Manned space station for testing components and techniques in the space environment. Design under study by NASA and AF	NASA and AF contending for program. Decision expected late 1963. NASA has requested bids on four study concepts. Flights in post-1967 period
★MARINER (NASA)	JPL, prime	550-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1000-lb. MARINER B also under development	Twelve shots planned. First scheduled Venus fly-by August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus Dec. 14; two Mars fly-by missions planned in late 1964
MDS (NASA)	Fairchild Stratos, prime	3400-lb. meteoroid detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit, 300 to 800 miles; booster SATURN 1	Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch scheduled for mid-1964; two will be orbited
MERCURY (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY made 22-orbit flight with L. Gordon Cooper on May 15. Program now completed
MIDAS, PROGRAM 239A (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads	Development; re-oriented system now funded for total of $450 million; funding of $150 million for FY '63 now cut to $100 million for FY '64

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**NIMBUS** (NASA)	Goddard Space Flight Center prime; GE, integration and testing; RCA, videcon cameras	2nd-generation weather satellite; Earth-stabilized polar orbiting; 750 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for early 1964; second, six months later; four R&D satellites, five Weather Bureau satellites planned
★**OAO** (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage	3500-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, ATLAS-AGENA D	Three flights beginning in 1965
★**OGO** (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA D, CENTAUR boosters	First flight scheduled in early 1964; 19 experiments planned for first shot; five other flights planned
★**OSO** (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; DELTA and ATLAS-AGENA boosters, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; five more flights planned; advanced OSO to be built by Republic
PIONEER (NASA)	STL	120-lb. spin-stabilized solar probe; DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; 4 outrigger booms for stabilization; 5 experiments, 60-to-90-million-mi. communication capability	Seven launches in program; early 1965 launch schedule set; orbits range from .8 to 1.2 au for 6-mo. lifetime
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket; Northrop, serving as support contractor, will be named prime in 1964	300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster	R&D RANGER VI launch postponed; program undergoing management change; five more RANGERS added to program—making a total of 14; plans call for a total of 22; next launch, third quarter 1963
★**RELAY** (NASA)	STL, project coordination and systems planning; RCA, prime	172-lb., spin-stabilized, wide-band, 700-4000-mile orbit active repeater experimental communications satellite. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; RELAY II November, 1963
SATELLITE INSPECTOR (SAINT) PROGRAM 706 (Air Force)	RCA, prime; Hughes, detection equipment	Anti-satellite inspection system also capable of destroying hostile vehicles	R&D; re-oriented; 3 study contracts to be awarded to determine characteristics of a SAINT vehicle, based on a manned system using GEMINI capsule
SAMOS (Air Force)	Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300-mile circular polar orbit	Operational; advanced SAMOS under development; FERRET version used for electronic intelligence and communications eavesdropping
★**SERT** (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched in late 1963
★**SLOMAR** (Air Force)	Lockheed, Martin studies completed	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded December, 1960; DOD studying concepts in connection with Manned Orbiting Development Station
★**SURVEYOR** (NASA)	Hughes, prime; Martin, SNAP device	2100-lb. spacecraft for soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; Moon-orbiting vehicle planned; SNAP nuclear generator optional	First Moon flights early 1965; seven soft-landing vehicles planned
★**SYNCOM** (NASA)	Hughes, prime	24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in dia. and will weigh about 55 lbs.; capable of accommodating one full duplex radio telephone channel	First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost. SYNCOM II launched July 26, 1963, completely successful. 500-lb. advanced SYNCOM to be developed
★**SMS** (Synchronous Meteorological Satellite) (NASA)	Republic, study contract	24-hour weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or CENTAUR	First flight 1966; No development funding in Fiscal '64 budget
TELSTAR (AT&T-NASA)	BTL, management for AT&T	170-lb., active repeater, experimental industry communication satellite; DELTA booster	Development; first launch July 10, 1962, highly successful; second launch May 7, 1963, also successful
TIROS (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (3000-mi. apogee)	R&D; seven satellites launched; all successful. Seven more added to program (4 R&D NASA, 3 operational, Weather Bureau)

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TRANSIT (Navy)	Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers	Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; SCOUT booster	Operational system in process of being established for use by POLARIS subs; NASA also will use TRANSIT for civilian navigation satellite system
★**VELA-HOTEL** (ARPA)	STL, prime; Los Alamos Scientific Lab/Aerospace, payload	20-sided, 485-lb. satellite for detection of nuclear explosions in space; 50,000-n.-mi. orbit; booster, ATLAS-AGENA	Initial launch planned for twin satellites in September or October
VOYAGER (NASA)	Study contracts, Avco Corp. & GE	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface	Funds may be in FY '65 budget. Launches in 1968-70 period. Spacecraft of 6,000 lbs. to be launched by ADVANCED SATURN
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics	Manned rocket plane; capable of 4000-mph plus flight at edge of space; each rocket engine develops 57,000 lbs. thrust; reentry flights providing data for X-20	Powered flights in progress; unofficial records set: altitude (351,000 ft) and speed (4159 mph); X-15 will be used as trainer for X-20

Space Vehicles

AGENA (Air Force)	Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion	1700-lb. upper stage; all-inertial guidance; re-start capability	Used in DISCOVERER, SAMOS and MIDAS programs; ATLAS, THOR boosters
BLUE SCOUT (Air Force)	Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	4-stage vehicle; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance	Operational; based on NASA's SCOUT; space probe and small (150-lb.) satellite launch vehicle; also AF's Hyper-Environmental Test System
CENTAUR (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, ATLAS D booster, capable of orbiting 8500 lbs.; 2300 lbs. to escape; 1300 lbs. on planetary flights	Development; program responsibility transferred from MSFC to Lewis; first flight test failed; late 1964 or early 1965 earliest possible operational date; next launch October, 1963
DELTA (NASA)	Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3-stage vehicle; 430 lb. payload capability in 500-mile orbit; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively; THOR missile comprises first stage	Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational this year
LITTLE JOE II (NASA)	General Dynamics/Convair, prime	Solid-propelled vehicle with thrust of 800,000 lbs.; launch vehicle for APOLLO suborbital flights	First launch scheduled August, 1963; six vehicles ordered thus far
NOVA (NASA)	General Dynamics/Astronautics and Martin awarded design study contracts; Martin, launch facilities study. Further studies to be awarded	Capability of NOVA under study; no firm concept but should offer significant improvement over C-5 (20-30 million lbs. 1st-stage thrust or nuclear upper stage)	Study to determine characteristics; operational target date post-1970 time period
ORION (Air Force)	General Atomic	Space booster propelled by series of atomic explosions to lift over 1000 tons into orbit	Studies; AF FY '64 request for $9.8 million denied by DOD; R&D continuing with funds re-programmed from FY '63
ROVER (NASA) AEC)	Los Alamos Scientific Labs, ROVER Prime; Lockheed, RIFT vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion	First nuclear rocket: tests of KIWI, prototype of NERVA engine, under way	First ROVER flight test expected before end of decade
★**SATURN I** (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO. 1st stage: 8 Rocketdyne H-1 engines; 2nd stage: 6 Pratt & Whitney RL10-A3 engines; 22,000 lbs. into 345-mi. orbit	Four flight tests of 1st stage successful; all flights with inert upper stage; first flight with live upper stages October-September, 1963
SATURN I-B (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas	S-1: 8 H-1 engines; S-IVB: 1 J-2 engine; payload capability, 32,000 lbs. in 345-mi. orbit	Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle
★**SATURN V** (Advanced Saturn) (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-IC, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American	S-IC: 5 F-1 engines; S-II: 5 J-2 engines; S-IVB: J-2 engine; 120-ton payload in 345-mile orbit; 43 tons to escape velocity; 30 tons for planetary missions	R&D; first flight scheduled for 1966; prime booster for APOLLO missions; may also be used to boost Orbiting Space Station
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 300-lb. payload in 345-n.-mi. orbit	Operational payload being increased to 300 lbs.; NASA has ordered 23 more boosters
★**TITAN III** (Air Force)	Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance	Quick-reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance	Development; first flight late '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned: 5 TITAN II core vehicles (A version), 12 full TITAN III's (C version); operational in 1965; 120-in. solid fired successfully July 20

ENGINEERS • SCIENTISTS

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Technical Countdown

ASTRONAUTICS

Lunar Terrain Orbits Earth

Significant amounts of lunar surface material scattered into space by meteorite impact escape the Moon's gravitational attraction and eventually wind up in elliptical orbits about Earth. In simulations at NASA's Ames Research Center, scientists found that lunar debris is thrown up and out of craters in a cone-shaped sheath of fragments and fused rock. A small fraction of this debris traveled at speeds up to 2 to 3 times that of the meteorite, or fast enough to escape lunar gravity. NASA scientist Donald E. Gault says from 1 to 10 tons of lunar surface material is lost each day. This is equivalent to an erosion of 2 to 20 lbs./sq. ft. of lunar surface each billion years. About 85-90% of the material goes into orbit around the Sun, while 10-15% goes into Earth orbit. Preliminary estimates place the concentration of lunar soil around the Earth at 10 to 100 times greater than the amount of interplanetary debris of comets and asteroids.

Eclipse Puzzle Noted by Stanford

Measurements by Stanford Radioscience Laboratory during the recent solar eclipse suggest that the shadow cast in the solar wind by the Moon may be at an unexpected angle. During the eclipse the Moon was illuminated with two continuous-wave rf beams: one at 50 mc and 50 kw, the other at 25 mc and 300 kw, using Stanford's 48 log-periodic antenna array and a 150-ft. dish. Measurements of Faraday fading and Doppler difference in the echos were designed to indicate any change in charged-particle density in cislunar space. If the Moon were immersed in a solar wind of charged particles, the change was expected to occur 2-5 hours prior to the eclipse. In fact, however, the expected change was observed during the visible eclipse, indicating a solar wind source of 1°. The unexpected arrival time might be accounted for by displacement of the Moon's solar-wind shadow by several degrees. Alternatively, the characteristics of the Earth's magnetosphere at distances up to 13 radii may have changed.

SPACE MEDICINE

'Martians' Home-Grown by NASA

NASA researchers have found that 18 species of Earth bacteria survived in "Mars jars," in which the atmospheric and gaseous conditions of Mars were simulated. Some of the bacteria, which were gathered from several of the more remote and climatically extreme points on Earth, were able to grow without apparent difficulty. One type is said by researchers to have enlarged itself by four or five times in the "Martian" atmosphere.

Astronaut-Stress Simulator Built

A unique piece of test equipment which simulates the kind of physiological readings—such as EKG and respiration waveforms—which might be generated by a person in stress has been developed by the Instrumentation and Electronics Systems Div. of NASA's Manned Spacecraft Center. The laboratory built the simulator when it was learned that laboratory subjects would not generate the same kinds of readings as would an astronaut actually in flight. The equipment is being used to check out various pieces of physiological telemetry equipment.

ADVANCED MATERIALS

New Type Pyrolytic Graphite Tested

The first of a series of tests on various configurations of a new pyroid type of pyrolitic graphite developed by Space Age Materials Corp. indicates the material can handle temperatures of 7,000°F and higher. The test itself exposed the material to 6,800°F and pressures up to 850 psi. While the throat surface was estimated to be at this temperature, the ⅝-in. back was under 600°F after 40 secs. at temperature. The chamber pressure remained constant during firing.

Helium Refrigerator Marketed

A completely integrated gaseous helium refrigerator system designed for environmental testing purposes is being marketed by Linde Div., Union Carbide Corp. The Mark II unit will cool to just under −432°F and its specific application will be in cryopumping vacuum chambers. The device can also handle such things as neon liquefaction, hydrogen recondensing, cryoelectronic cooling and maser refrigeration.

Diffusion Bonding Used In Honeycomb

Hexcel Products, Inc., is developing Astroweld, a method of joining metal alloys by solid-state diffusion bonding. Fabricated end-products—honeycomb and sandwich—reach the full wrought properties of the parent materials. The process uses controlled conditions of temperature, time, pressure and atmosphere to achieve the diffusion bond. Operating temperature is below the base metal recrystallization temperature. Two routes are used by Hexcel: one is direct metal-to-metal bonding and the other involves an intermediate material in the joint area to promote the bond. Hexcel claims the main advantages include minimum weight, design flexibility and substantial cost savings over conventional brazing.

ELECTRONICS

Getting Electricity Out of an Echo

Electricity would be generated in space by *Echo*-satellite-type thin structures in a direct nuclear electrogenerator system envisioned by NASA and mentioned in the agency's recent Technical Note, "Important Structural Research Problems for the Support of Future Space Missions," TN-2059, p. 11. The proposed structure would consist of two concentric spheres made of foil—an inner sphere coated with a radioisotope emitting alpha or beta particles, and an outer sphere of the order of 30-80 ft. in diameter. The potential difference between the two spheres would generate power.

Houston Wants GaAs Laser Communications

NASA's Houston Manned Spacecraft Center presented its requirements for laser optical communications system for manned Earth-orbiting spacecraft last week. RFP's went to 44 firms initially, but at least 65 are expected to respond. System envisioned will provide a one-way channel to ground and will be designed around a gallium-arsenide laser diode.

HDL Notes GaAs Radiation Effects

Luminescent output of gallium-arsenide diodes is greatly reduced by neutron bombardment, say scientists at the Harry Diamond Laboratories, White Oak, Md. Light emission began to fall when the elements were subjected to total integrated flux of 10^{12} nvt and at a level of 5 x 10^{13} nvt the light output dropped to 10% of its pre-radiation value.

missile support

Martin Method Cuts Si

Refurbishment of Vandenberg AFB Titan II 'tubes' slashed from 16 to 3½ days; system allows savings estimated at $155,000 per restoration; inexpensive manlift is key

MARTIN REFURBISH task force chief Bernie O'Neill (right) on manlift, with C. E. Carnahan, director of Martin's Vandenberg operations.

VANDENBERG AFB, CALIF.—*Titan II* silo refurbishment here has been cut from a 16-day to a mere 3½-day operation with a system developed by a Martin Co. engineer.

Heart of the system is a conveyor-belt manlift fabricated and installed in nine days by The Conveyor Co., Los Angeles, on a $15,000 purchase order. Cost of the manlift—a vertical belt with a dozen footstands, each of which carries a workman to any except the bottom level of the silo—was covered by savings gained on two shifts.

Whereas refurbishment formerly required 32 shifts of 10 hours each, it is now accomplished in an average of only seven shifts, including five 10-hour and two 8-hour shifts. The Air Force conservatively estimates that the system enables savings of $155,000 per restoration, based solely on man-hour savings of the refurbishment crew and not including man-hours formerly lost by site personnel and R&D staff during the refurbish operation.

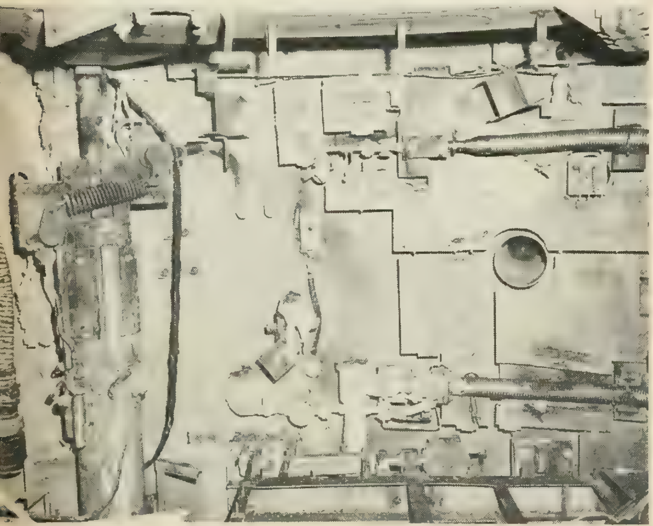
The first refurbishing job required 222 workmen. The new system has cut that figure in half.

● **Reasons why**—Air Force and Martin spokesmen listed in this order the reasons for returning Vandenberg silos to operational status as soon as possible:

—R&D work is speeded, greatly aiding the concurrency concept in weapon development and system improvements.

—Strategic Air Command missile crews can move through final training much faster.

—Vandenberg silos can be returned to Emergency War Orders (EWO) capability after a launch in a fraction of the time previously required. (During the Cuban crisis last year, Vandenberg *Titan I* silos were ordered on EWO status.)



pair Time

by Willard E. Wilks

It is conceivable that the latter point could become the number-one reason for fast refurbish operations in the future, one source told MISSILES AND ROCKETS. "Thought has been given to the idea of enabling a second wartime launch by missile squadrons. Perhaps this capability would be desirable with future ICBM systems. It is believed that refurbishment could be accomplished in a day, perhaps less."

- **Best yet to come**—Bernie O'Neill, manager of Martin's refurbish task force, said silo restoration time probably could be cut still further with the Martin system. O'Neill is credited with devising the system and the management technique that so far has been used in three *Titan II* silo refurbish operations with significant reduction in time and cost each time. Two of three *Titan II* silos at Vandenberg had been refurbished previously. Latest was the "C" site, which has undergone three restorations. Officially, the "C" and "D" sites are set aside for R&D purposes, and the "B" site, not yet fired, is for SAC training. All three are in the process of development for turnover to SAC, with one scheduled for turnover in the near future.

In addition to the major savings made possible by O'Neill's system, ways are being found to save on materials and equipment—but with improvement of the silo always the major objective—as development of the *Titan II* holes proceeds. In each launch, new materials, components and techniques are tested.

- **Varied challenge**—No two launches ever produce the same damage. The most recent refurbishment was accomplished in record time even though the launch caused twice the damage of the previous firing. This greater damage occurred partly because some of the acoustical modules had already been subjected to two launches. Also contributing to the increased damage was the fact that it was a hotter firing, with the engines producing more thrust—intentionally, although there are differences in engine performance that make it impossible to predict the extent of heat damage. Loss of acoustical modules averages 800 units or more for a launch, and can be as low as 72 in a static firing. Each silo has 1,290 modules, including 372 in each exhaust duct, and 546 in the launch duct.

The Air Force estimates a cost of $500,000 per refurbishment, including labor and materials. Major materials cost is in replacement of the box-like acoustical modules that line the silo, top to bottom. This value approaches 50% of the total. Greatest module loss is in the exhaust ducts, which are almost entirely cleaned out.

Many modules simply vanish from the silo walls (in at least one instance exposing a silo defect that inspectors had overlooked—a 21-ft. crack where concrete had not filled in around a pipe during pouring). Some wind up as crumpled bits of trash outside the hole; others are left hanging in burned and melted shreds.

Cost of replacing modules is expected to be reduced considerably by a new stainless-steel unit which has yet to be subjected to a launch. Present modules are aluminum units packed with leached glass wool.

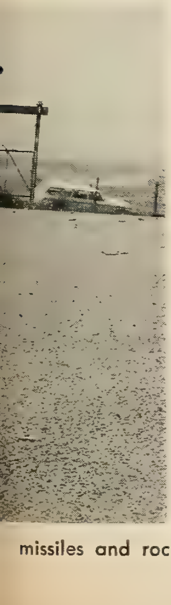
Silo equipment formerly lost, but now being saved, includes the four $1,800 liftoff switches. An official explained that some of the methods devised to prevent loss are make-shift but effective—such as wrapping electrical cables with asbestos tape.

- **On the spot**—The 125-ft. manlift conveyor is only a part of the management system devised to speed up refurbishment. Every aspect of the effort has been coordinated to make refurbishment an entirely autonomous, on-the-spot operation. People, equipment, and materials formerly were located in back areas as far as five miles from the scene, but everything now is brought to the edge of the hole before work starts—this includes management, engineering and subcontractor offices; warehouses; welding, electrical, pipe and carpentry repair shops; steam cleaning equipment; procurement personnel and a 35-ton crane. Three portable knock-down buildings are hauled up on trailers and assembled; four trailers house offices, small stock items and serve as warehouses.

All materials, spares and supplies are assembled on pallets. Before any major work begins, damage is photographed throughout the silo. Installation of the manlift requires no silo configuration changes. Four bolts hold it at the silo lip, and at each level in the silo it is held in place by removable platforms that are simply set on existing catwalks. A 440-volt motor drives the conveyor at 60 ft./min., and it can be stopped at any moment by any workman with a pull on a rope alongside the belt.

The manlift belt also is being used for silo modification work, and Martin believes the principle can be applied easily in the primary construction phase of silos, gantries and the partially buried launch sites planned for big rocket systems of the future.

The Air Force prefers to stress development of the refurbish technique not as a cost reduction item, but as a management improvement brought about through industry-Air Force cooperation. "From the moment Bernie came up with this idea, there was never a hitch," one spokesman said. ■



FAR LEFT: Damage to acoustical modules, vertical damper and umbilicals. LEFT: Ground near facility is littered with debris from modules immediately after launch. RIGHT: Damaged acoustical modules in exhaust duct.

Six-Launch Bios Series Starts in '65

GE satellites to carry primates on long missions; first use of two-gas atmosphere

by Heather M. David

AWARD TO General Electric Co. of a $19-million NASA contract for the *Biosatellite (Bios)* system is the culmination of a campaign begun several years ago to insure that human astronauts would not be called upon to serve as space guinea pigs.

There has been strong feeling within the medical community, particularly among the military, that extensive biological research should be conducted in space with animals before humans face long-duration exposures. While launches of *Biosatellite* will not begin until 1965—and thus will not provide many data for *Gemini* and early phases of *Apollo*—the long-term primate flights will gather much information in advance of long-duration manned flights. Six launches at three-month intervals are planned. Later, there may be further work in either additional *Bios* spacecraft or perhaps in a *Manned Orbital Research Laboratory (MORL)*, although neither of these programs has yet been approved.

Bios will be the first U.S. spacecraft to employ a two-gas (20% oxygen, 80% nitrogen), sea-level atmosphere. This has been the subject of a crusade by a number of space physicians (M/R, May 6, p. 14; May 13, p. 15, Aug. 5, p. 20).

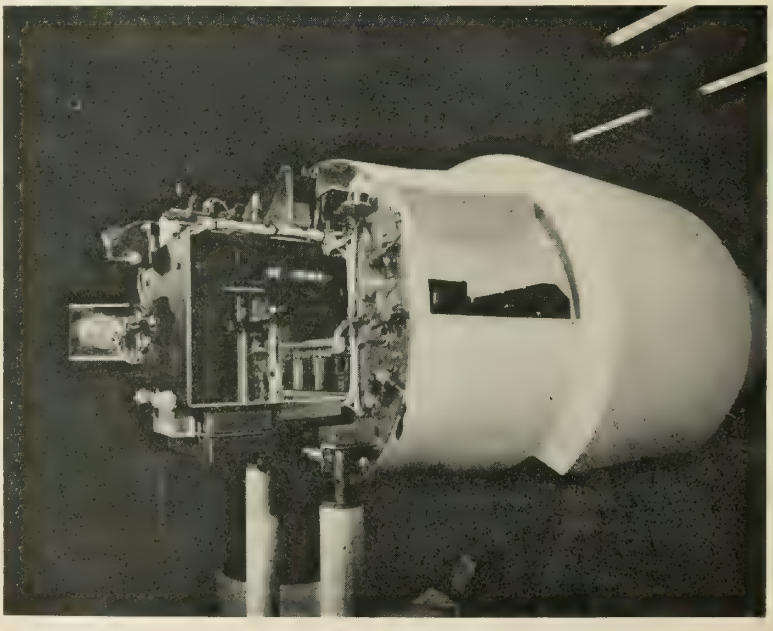
- **Experiments**—While more than 50 experiments have been tentatively okayed for the *Bios* program, NASA still is looking for experiments for the first six satellites. Dr. Dale Jenkins, program chief for environmental biology at NASA headquarters, told MISSILES AND ROCKETS that another selection will be made in about two months. He said the Biosciences group is interested in all four groups of experiments, which are: (1) weightlessness at the cellular level, (2) combined weightlessness and radiation, 3 to 5 days, (3) weightlessness and biological rhythms, 21 days, and (4) prolonged weightlessness on primates, 14 to 30 days.

Dr. Tom Dallow is NASA headquarters program manager, while Dr. C. Bioletti is Ames Research Center project manager.

One or two of the first six satellites probably will contain monkeys, agency spokesmen said. Pig-tailed monkeys probably will be used, with implanted sensors to study cardiovascular and brain and nervous system activity during weightlessness. Flight duration will be 14 to 30 days.

Another monkey experiment, in a

BIOSATELLITE
NASA



ABOVE: Mockup of GE's Biosatellite shows close resemblance to Discoverer series. RIGHT: View from rear shows control components including magnetometer and one of IR sensors used in de-orbit mode. Dark units in center section are attitude control components.

group of studies of biological rhythms, will employ a small squirrel monkey in a circular, unrestrained cage. This will afford an opportunity to study a primate away from the effect of the Earth's rotation.

One satellite experiment will employ a radiation source—probably cesium 137 or cobalt 60—to study the combined effects of radiation and weightlessness.

The spacecraft will be launched from Cape Canaveral and either air-snatched or recovered in the sea somewhere near Hawaii. Planned orbit is equatorial and circular, around 200-mi. altitude, with a 28° to 33° inclination.

Experiments will be installed on the rocket about three hours before launch and will be subjected to an estimated maximum 12 g's during power flight.

- **Spacecraft details**—General Electric's Re-entry Systems Division banked heavily on its experience in *Discoverer, BIOS I, Nerv* and *Orbiting Astronomical Observatory (OAO)* to win the *Biosatellite* contract.

The re-entry vehicle is essentially a scaled-up *Discoverer,* with much the same materials and heat shield.

The stabilization and control systems borrow *OAO* techniques and components. Separate sensing systems are used for orbital and de-orbit models.

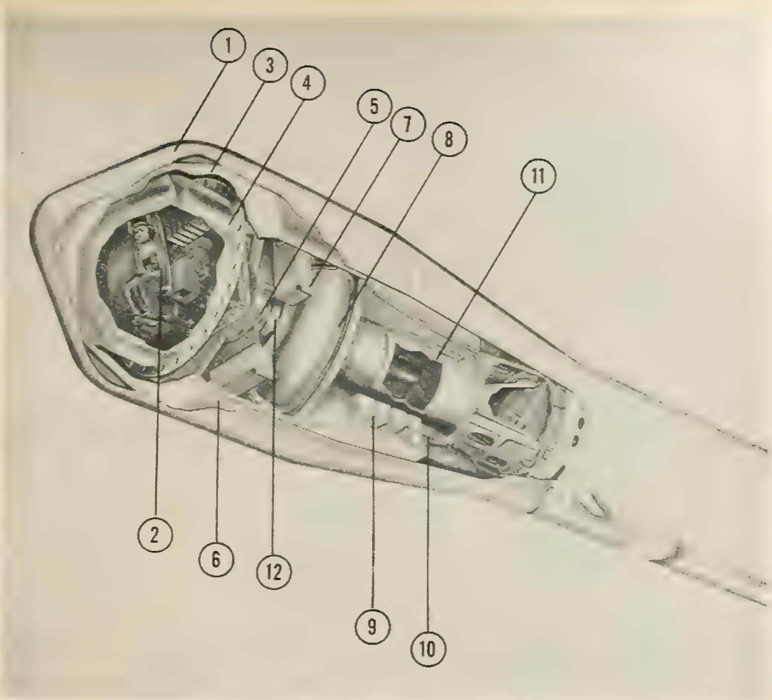
One of the most important requirements of *Biosatellite* is that in-orbit accelerations are held to a minimum to keep from interfering with the weightlessness experiments. The spacecraft is inherently aerodynamically stable and will align to the velocity vector, but requires rate damping. Three rate gyros will sense in-orbit rates, and a nitrogen cold-gas reaction jet will stabilize the spacecraft.

GE's engineers tested the control system with a "brassboard"—a full scale, 1,000-lb. engineering mockup of the spacecraft—and demonstrated it on an air bearing. They also experimented with a six-lb. monkey to see if his movements affected the spacecraft, but concluded that perturbations caused by the biological specimens would not be large enough to require correction by the attitude control system.

NASA's requirement for the attitude control system is that in-orbit accelerations be limited to less than 10^{-5} g for at least 95% of the mission, and a total of 10^{-4} g for the entire mission.

Added components are used for the de-orbit mode, since the spacecraft must be oriented. Two infrared sensors and a magnetometer are then employed, the IR for pitch and roll, the magnetometer for yaw reference. Optimum pitch down angle is 135° in the orbit plane, ±5°.

The spacecraft presently envisioned by GE will have redundancy in its rate gyros and most components of its attitude control system.



ARTIST'S DRAWING of GE-proposed Bios spacecraft shows: 1) extended bulbous fairing, 2) primate, 3) re-entry vehicle, 4) recoverable experiment capsule, 5) de-orbit retro-rocket, 6) spacecraft adapter section, 7) batteries (three-day supply), 8) cryogenic storage-toroidal tank, 9) TT&C subsystem components, 10) attitude control components, 11) X-258 Delta third stage, 12) Gemini fuel cell—single stack.

- **Other subsystems**—GE project engineering manager Vince de Liberato told M/R there were no problems in designing the two-gas atmosphere. Probably only oxygen and total pressure will be sensed, using cryogenic gas supplies.

The integrated tankage system will provide nitrogen for the attitude control system as well as cabin atmosphere. Temperature of the capsule is to be maintained at 75° ±2° for the first two classes of experiments (cellular and small organisms in weightlessness; and biorhythms) and 75° ±5° for the primates. Humidity ranges from 40 to 70%.

Telemetry will be pulse code modulation, with recording of data during re-entry and splash and recovery periods for some experiments. All bioinstrumentation and other sensing equipment for the experiments must be furnished by the experimenter or NASA.

Power supply may be by fuel cell, although NASA may change a number of details from the GE proposal.

- **Flight profile**—The first two groups of experiments will be launched on a *Thor-Delta* vehicle. The 30-day primate mission spacecraft, although weighing only slightly more, may require the *Thrust-Augmented Delta (TAD).* Average weight is 1,000 lbs.

After launch and staging, the fairing is jettisoned and the spacecraft and stage III rocket motor is spun up to 90 rpms for trajectory stabilization. The third stage is then separated and a "yo-yo" system despins the spacecraft.

The telemetry and tracking subsystem is on the beacon mode for ground-station tracking during the first several orbits. The command system will respond to real-time commands from ground stations at any time.

De-orbit sequence is initiated by a one-word, stored command. A pre-programed roll-pitch maneuver will be used to acquire the Earth, with the use of the complete attitude control system. The adapter is then separated, the spacecraft once again is spun up, decelerated and despun, and the thrust cone is jettisoned.

GE engineers said that the re-entry vehicle will align its center line to the velocity vector because of the aerodynamic forces.

After the spacecraft re-enters, the aft-thermal cover is ejected, deploying a parachute system. The heat shield also falls off at this time.

While it is possible that the re-entry vehicle can be "caught," it will weigh several hundred pounds—more than the *Discoverer* capsule. The *Biosatellite* will be buoyant for some hours, and dye markers and radio equipment will be used to locate it in the water. ■

QUESTIONS SELECTED FROM RECENT EMPLOYMENT ADS WE HAVE READ

Is your workground your playground?
Are you a duck hunter; one with purposeful imagination?
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At MCDONNELL, we have just one question for you:

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We have work to do here. We have the facilities to do the work and the contracts, both prime and sub, to stimulate your production. Our location, St. Louis, suits us fine and we think you'd like it here too. The work is interesting and the pay is good. So Let's Swap Resumes. You send us yours, we'll send you ours.

Please complete this form and forward to: Mr. D. F. Waters, Professional Placement, Dept. 62MM, McDonnell Aircraft, St. Louis 66, Missouri. *This is not an application for employment.* Your qualifications will be reviewed by our placement staff and you will be advised of positions at McDonnell for which you qualify. You may then make application if you wish. All replies confidential.

Name____________ Home Address____________
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Additional Comments____________

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Gemini, Asset and Aeroballistic Spacecraft • Fighter and Attack Aircraft • Reconnaissance Aircraft • Talos and Typhon Missile Airframes and Engines • Electronic Systems • Automation

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Circle No. 9 on Subscriber Service Card

Mergers and Acquisitions

Xerox Corp., Rochester, N.Y., is purchasing Electro-Optical Systems, Inc., Pasadena, Calif., for approximately 55,000 shares of Xerox common stock. EOS, engaged in development of spacecraft power and advanced space propulsion systems, will be operated as a subsidiary of Xerox. Xerox manufactures machines and supplies for the field of graphic communications. . . . *Energy Systems, Inc., Palo Alto, Calif., has acquired Radiation at Stanford for $1,252,000. Radiation at Stanford, which has developed high-power electronic devices and systems, was formerly a subsidiary of Radiation, Inc., Melbourne, Fla.* . . . Ransom Research, San Pedro, Calif., a division of Wyle Laboratories, El Segundo, Calif., has been merged with the Wyle Manufacturing Div. and has moved to an 8,000-sq.-ft. addition at the manufacturing plant. The Ransom products, which include all-solid-state digital logic modules, instruments and systems, will be added to the company's line of environmental test chambers and systems for electronic components. . . . *Electronic Communications, Inc., St. Petersburg, Fla., has purchased approximately 75% of the voting stock of the Benson Manufacturing Co., Kansas City, Mo. Benson is a metals fabricator that subcontracts to major aerospace systems suppliers. ECI is active in the electronic communications field and manufactures precision equipment for the aerospace industry.* . . . Computer Applications, Inc., New York City, has acquired Electronic Business Services Corp., New York City, a data processing center. Computer Applications provides programming and analysis services to government and industry on advanced data-processing systems and techniques.

New Firms and Divisions

Monogram Industries, Inc., Hawthorne, Calif., has established the Fastlok Div. as an independent operation in a new plant. Formerly the Clamp Div. of Monogram, Fastlok will continue to manufacture clamping devices for the missile/space, aircraft and other industries. . . . *American Nucleonics Corp. has been formed in Glendale, Calif. The firm will engage primarily in nuclear engineering, electronics, bionics and plasma science.* . . . Lel, Inc., Copiague, N.Y., has established a division to be known as Lel West in Phoenix, Ariz. The new division will operate primarily as a research and development laboratory and to provide engineering assistance to area customers. . . . *Economy Blueprint & Supply Co., a division of Continental Graphics Inc., Los Angeles, has opened an administrative office in Cocoa Beach, Fla. The new office is an expansion of the firm's printing and reproduction facility in Cape Canaveral, Fla., operated for NASA.*

Industry Facilities

Fenn Manufacturing Co., Newington, Conn., a producer of high-precision aircraft and missile components and metal-forming machinery, is completing a $1 million program of machine tool modernization. . . . *The Linde Div. of Union Carbide Corp. is constructing a spherical tank for the storage of liquid gas at super-cold temperatures at its liquid hydrogen plant being built at Sacramento, Calif. The tank, which will have a capacity of approximately 700,000 gal. of liquid gas, consists of an aluminum inner sphere 57 ft., 4 in. in diameter, and a steel outer sphere, 64 ft., 4 in. in diameter. Granular insulation will separate the spheres to help keep the liquid hydrogen at −423° F.* . . . Enthone, Inc., New Haven, Conn., a subsidiary of American Smelting and Refining Co., has established warehouse facilities in Camden, N.J., and Greensboro, N.C. Enthone deals with specialty chemicals for metal finishing and electroplating.

International

Aerojet-General Corp., Downey, Calif., has agreed to share a new metalworking technique with two Mexican firms, Industria del Hierro and Consorcio Industrial, both of Mexico City. The firms have been given exclusive Mexican rights to a process used for explosive forming of large or difficult-to-shape metal pieces. Aerojet, a space technology firm, developed the metalworking method for space research. . . . *Twin City Testing Corp., Tonawanda, N.Y., has concluded an agreement with the French atomic energy commission for American rights to an apparatus that measures thicknesses and analyzes alloys by X-ray fluorescence. TCT manufactures nondestructive thickness testers.*

Company Representatives

Stewart Engineering Co., subsidiary of Watkins-Johnson Co., Santa Cruz, Calif., has named five sales representatives. Stewart specializes in backward-wave tubes and related electron devices. Representatives include: Perlmuth Electronic Instrumentation, Los Angeles, Palo Alto, San Diego, Phoenix, Albuquerque, Denver and Salt Lake City; Lancer Associates, Lexington, Mass.; Ossman Instruments, Rochester, Syracuse and Vestal, N.Y.; Eastern Instrumentation, Inc., Philadelphia, Great Neck, L.I., and Baltimore; and S. Sterling Co., Detroit, Cleveland and Dayton. . . . *Engineered Electronics Co., Santa Ana, Calif., has appointed four firms to represent its EECoSWITCH Dept., producers of digital thumbwheel switches and miniature indicators. Representatives are: E. V. Roberts & Associates, Inc., Los Angeles; Ray Johnson Co., Inc., Seattle; Samuel C. Hooker, Inc., Winchester, Mass.; and Samuel C. Hooker Ltd., Montreal, Canada.* . . . Allied Chemical Corp., New York City, has been named U.S. distributor for Cominco Products, Inc., Spokane. ACC will handle ultra-high purity metals produced by Cominco. . . . *J. Neal & Co, Miami, has been appointed sales representative for Breeze Corp., Inc., Union, N.J. Neal will market electronic products in the Southeast.*

AWARDS

AIR FORCE

$5,000,000—**Thiokol Chemical Corp.**, Bristol, Pa., for research and development work on solid propellant rocket motors at Huntsville, Ala., and Brunswick, Ga.

$4,800,000—**Peter D. Kiewit Sons Co.**, for updating *Titan I* missile facilities at Lowry AFB, Colo., Ellsworth AFB, S.D., Mountain Home AFB, Idaho, Larson AFB, Wash., and Beale AFB, Calif.

$3,000,000—**Aerojet-General Corp.**, Azusa, Calif., for research work on solid propellant motors at Sacramento, Calif., and Dade County, Fla.

$2,500,000—**Acoustica Associates, Inc.**, Los Angeles, for development and production of propellant utilization systems for space launch vehicles.

$2,202,900—**E. W. Bliss Co.**, Canton, Ohio, for manufacture of parts for the *Minuteman* missile.

$2,000,000—**Western Electric Co.**, New York City, for management of SAGE air defense system.

$1,700,000—**Boeing Co.**, Seattle, for assembly of *Minuteman* missiles.

$1,300,000—**Radiation, Inc.**, Melbourne, Fla., for production of telemetry equipment for the *Minuteman* missile.

$999,518—**Martin Marietta Corps.**, Baltimore, for maintenance of *Mace* weapon system in the Pacific theatre.

$698,888—**Martin Marietta Corp.**, Baltimore, for maintenance of *Mace* weapon system in the European theatre.

$556,141—**Goodyear Aerospace Corp.**, Akron, Ohio, for repair and modification of nose sections and related ground support equipment for the *Mace* weapon system.

$317,000—**Lockheed-California Co.**, Burbank, for a study of aerothermoelastic instabilities of typical aerospaceplane configurations.

$64,899—**Thiokol Chemical Corp.**, Elkton, Md., for rocket motors and igniters for sled use.

$49,645—**National Research Corp.**, Cambridge, Mass., for research studies relating to detection of leaks in a large aerospace systems environmental chamber at Arnold Engineering Development Center, Tullahoma, Tenn.

$32,333—**Physics Technology Laboratories, Inc.**, La Mesa, Calif., for development of an earth-orbital charged particle simulator.

ARMY

$4,000,000—**C. H. Leavell & Co., Morrison-Knudsen Co., Inc.**, and **Paul Hardeman, Inc.**, for construction of a Thermochemical Test Area at NASA's Manned Spacecraft Center, Houston, Tex.

$500,000—**Raytheon Co.**, Machlett Laboratories, Springdale, Conn., for development of a classified item.

NAVY

$6,600,000—**Loral Electronics Corp.**, New York City, for classified electronics equipment.

$5,500,000—**Westinghouse Electric Corp.**, Baltimore, for continued development of guidance equipment for the *Typhon* missile.

$1,100,000—**Northrop Corp.**, **Nortronics Div.**, Norwood, Mass., for continued production of *Polaris* missile gyroscopes.

$197,800—**Bermite Powder Co.**, North Hollywood, Calif., for igniter rocket motor assemblies.

$139,391—**Hercules Powder Co.**, Wilmington, Del., for filament winding of X-259 rocket motor chamber.

$115,159—**Philco Corp.**, Lansdale, Pa., division, for developmental work on Voltacap semiconductor diodes used for electronic tuning.

$96,000—**Sanders Associates, Inc.**, Nashua, N.H., for a development program for the application of lasers.

$59,564—**Philco Corp.**, Lansdale, Pa., division, **Special Products Operation**, for research and development to obtain semiconductor mixer diodes for counter-measure equipment.

Fairchild Camera and Instrument Corp., Space and Defense Systems Div., Syosset, N.Y., for production of panoramic reconnaissance systems (undisclosed amount).

NASA

$30,000,000—**United Aircraft Corp., Pratt & Whitney Div.**, for completion of RL-10 liquid hydrogen rocket engine qualification program at East Hartford, Conn., and West Palm Beach, Fla.

$3,600,000—**Aerojet-General Corp.**, Sacramento, Calif., for design, development and fabrication of a 1.5-million-lb.-thrust liquid hydrogen-liquid oxygen rocket engine.

$3,500,000—**International Business Machines Corp.**, Rockville, Md., for *Saturn V* airborne digital computer.

$1,000,000—**General Dynamics Corp., Astronautics Div.**, San Diego, Calif., for activation of Atlantic Missile Range launch complex 36B for *Atlas/Centaur* configuration. Work to be performed at Cape Canaveral.

$966,000—**ARINC Research Corp.**, for research and engineering services in support of the *Saturn* reliability program. Work to be performed at Huntsville, Ala.

$127,000—**Wismer & Becker**, Sacramento, Calif., for communication and control cabling at Plum Brook Station, Sandusky, Ohio.

$112,600—**American Machine & Foundry Co., Advanced Products Group**, Stamford, Conn., for fabrication of a hydraulic supply unit for the *Saturn* program.

$107,942—**The Display House, Inc.**, Philadelphia, for exhibit displays.

$97,817—**General Electric Co.**, Philadelphia, for continuous microwave magnetic accelerator.

$80,000—**General Electric Co.**, Philadelphia, for incremental funding of contract for ablative materials study for rocket engines.

$34,200—**Control Data Corp.**, Minneapolis, for furnishing digital control and communication unit for use at Cape Canaveral Launch Operations Center, Fla.

$27,132—**Xerox Corp., Electro-Optical Systems Div.**, Pasadena, for development of liquid hydrogen film-cooled pressure transducers.

Ipsen Industries, Inc., Rockford, Ill., for development of foamed metals for application on space capsules (undisclosed amount).

INDUSTRY

$2,202,900—**E. W. Bliss Co.**, Canton, Ohio, from the **Allison Div. of General Motors Corp.**, for production of parts for the *Minuteman* missile.

$1,300,000—**Radiation, Inc.**, Melbourne, Fla., from the **Boeing Co.**, for *Minuteman* ICBM telemetry system components.

$750,000—**Bendix Corp., Bendix Pacific Div.**, North Hollywood, Calif., from **General Dynamics Corp.**, for design, development and manufacture of primary flight surface control servo actuators.

$750,000—**United ElectroDynamics, Inc.**, Pasadena, Calif., from **Collins Radio Corp.**, for signal conditioning dc amplifiers for use in telecommunications equipment on board the *Apollo* spacecraft.

$371,000—**Bendix Corp., Eclipse-Pioneer Div.**, Teterboro, N.J., from the **Boeing Co.**, for development of a two-gyro stable platform for an emergency re-entry subsystem for the *X-20* spacecraft.

$319,000—**General Electric Co., Semiconductor Products Dept.**, Syracuse, N.Y., from **North American Aviation, Inc.**, for provision of microelectronic circuits for the improved *Minuteman* missile.

$260,000—**Cosmodyne Corp.**, Hawthorne, Calif., from the **Boeing Co.**, for development of a nitrogen purge system for use aboard the *X-20 Dyna-Soar* spacecraft.

$235,000—**Allegany Instrument Co.**, Cumberland, Md., from the **Boeing Co.**, for design, development and fabrication of instruments for the *X-20 Dyna-Soar* spacecraft.

$200,000—**United ElectroDynamics Corp.**, Pasadena, from **Fairchild Stratos Corp.**, for design, development and fabrication of seven temperature sensing systems for use in the NASA *Micrometeoroid Detection Satellite*.

$132,000—**General Electric Co.**, West Lynn, Mass., from the **Boeing Co.**, for instruments for the *X-20 Dyna-Soar* spacecraft.

$125,000—**United ElectroDynamics Corp.**, Pasadena, for design, development and manufacture of four flexible high speed mixed high-and-low level PCM system to be utilized at Edwards AFB, Calif., on the lunar landing simulator program.

$70,745—**Philco Corp., Lansdale, Pa., Div., Special Products Operation**, from **Massachusetts Institute of Technology**, for development of ultrahigh frequency switching transistors.

Minneapolis-Honeywell, Aeronautical Div., Minneapolis, from **Martin/Orlando**, for preparation of preliminary designs for high performance control system components for the *Sprint* anti-missile missile (undisclosed amount).

Day & Zimmerman, Inc., H. L. Yoh Co. Div., Fort Lauderdale, Fla., from **McDonnell Aircraft Corp.**, for provision of engineering services at Cape Canaveral (undisclosed amount).

Haveg/Reinhold Engineering and Plastics Co., Inc., Santa Fe Springs, Calif., from **Aerojet-General Corp.**, for fabrication of first complement of production units of Alcor motor cases and nozzles for the *Athena* missile (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Tape recording/reproducing system consisting of reel-to-reel and continuous loop tape transport with shared electronics—lot—RFP—A-7584. RFP due date 9-9-63. Requests for IFB or RFP will be furnished to the extent available on a first-received, first-served basis.

National Aeronautics and Space Administration
Goddard Space Flight Center
Glendale Road
Greenbelt, Md.

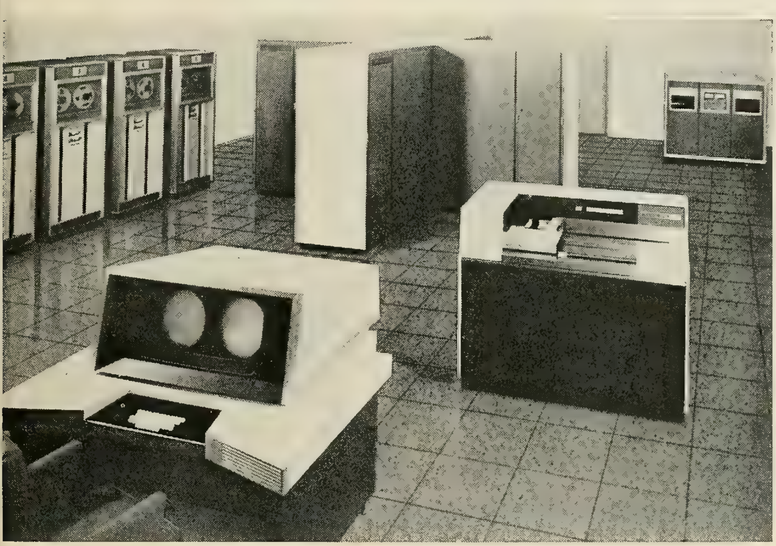
Launch phase simulator—item—RFP SC-772. RFP due date 10-4-63.

Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

Data motion analyzer—1 each. Angle measuring screen—1 each. Projection head 16mm—1 each. Projection head 35mm—1 each. Projection head 70mm, 35mm, and 16mm. Delivery to Ellington AFB, Tex. IFB MSC 64-285B. RFPs available through 9-13-63 unless sooner exhausted.

Study for concept and development of sea retrieval equipment for recovery of *Gemini/Apollo* spacecraft from the open sea. Deliver to the Manned Spacecraft Center, Houston, Tex. RFP No. MSC 64-831P. RFP due date 9-23-63. RFPs available through 9-13-63 unless sooner exhausted.

Control Data Computer Exceeds Specifications



Control Data Corp. has released details on its new 6600 computer, the first of which is scheduled for delivery to the U.S. Atomic Energy Commission's Lawrence Radiation Laboratory next spring.

Use of silicon components in the circuits of the computer, along with simplified basic circuit design, enable the 6600 to execute an average of over 3 million instructions per second. Performance is said to be three times faster than original specifications required.

The freon-cooled system will run 11 different programs simultaneously without time-sharing and can serve a number of individual problems at one time.

Circle No. 225 on Subscriber Service Card

Electronics Cooling Valve

Pyrodyne, Inc., has developed a valve for use in aerospace/electronic cooling systems and offering fluid temperature regulation without external power requirements.

A feature of the Model 4150 is an "extension cord" sensor which enables fluid temperatures isolated from the control valve to be sensed. Hot and cold mixing is automatically regulated so that fluid of desired temperature is directed to one or both outlet ports of the valve at all times.

The over-all operating temperature range of the valve is —65° to 160°F. The adjustable temperature control range is 70° to 120°F with a tolerance of ±3°F. The device is designed for an operating pressure of 30 psig, proof pressure of 100 psig and burst pressure of 200 psig.

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High Current Power Modules

Standard high current dc power modules developed by Valor Instruments, Inc., are designed so that RFI sources are either eliminated or suppressed, resulting in conducted and radiated interference levels that are well within the specification limits of MIL-I-6181D and MIL-I-26600. Audio frequency conducted susceptibility data is also available.

The ResisTran series of highly regulated power modules has outputs ranging from 4 to 30 amperes at voltages from 6 to 40 vdc.

All units have two mounting surfaces for mounting flexibility. In addition, most of the units can be mounted two per 5¼ x 19-in. rack panel.

Specifications: outputs 6 to 40 vdc at 4 to 30 amperes; regulation, 5 mv; ripple, 3 mv; remote programming; remote sensing; overload protection.

Circle No. 227 on Subscriber Service Card

Data Insertion Converter

A solid-state data insertion converter that will generate a complex of up to three composite FM/FM telemetry signals using standard IRIG subcarriers, has been introduced by Defense Electronics, Inc.

The DIC-1 has positions for up to 20 plug-in subcarrier oscillator modules. Each module may be switched in or out of any one or all of the three self-contained mixers. Three independent level controls on each module allow for complete flexibility in adjusting deviation schedules for the three multiplexers.

Circle No. 228 on Subscriber Service Card

Digital Signal Simulator

The Telemetrics Model 510 Digital Signal Simulator is said to handle all major formats, including *Saturn, Minuteman, Titan II* and *OAO*. Its completely programmable coded output includes RZ, NRZ mark and space, and biphase or bipolar. Serial and parallel outputs are available simultaneously.

Three different word lengths, from 2 to 33 bits, may be generated simultaneously. The Model 510 may be programmed to stop on any word in the format, and each bit may then be manually and sequentially read out. Common words may be coded in three modes: by manual switches, by internal random generator, or by automatic counting within the main frame on an 8-bit basis.

Bit rates may be controlled from either internal or external oscillators, and are continuously adjustable from 10 to 1,000,000 bits per second.

Five separate words may be gen-

NEW from DEI

FOR 1970 SPACE PROGRAMS...
The 2.2-2.3 Gc UHF Telemetry Receiver...Now!

- 2200-2300 Megacycle Tuning Range
- VFO or Crystal Controlled One Knob Tuning
- Complete Predetection Record and Playback Capabilities
- Plug-In Features for Economy and Versatility

The most versatile UHF telemetry receiver available *today* capable of fulfilling the frequency ranges assigned for 1970 space programs is the TMR-21, UHF Telemetry Receiver from Defense Electronics, Inc.

This unit has already been successfully used in all the Saturn rocket firings and will be employed in the Mariner B probes for Mars. It will not only meet standard FM/FM and PDM/FM applications, but PCM/FM requirements as well in systems using up to one million bits per second.

In addition to its tested frequency stability and flexibility in bandwidth selection, the unit employs one knob tuning for either VFO or crystal controlled mode of operation.

The TMR-21 can accept various DEI plug-in IF amplifiers to determine predetection bandwidth and, together with simultaneous FM and AM detection and adjustable FM video bandwidth, makes the receiver tailor-made for any ground station telemetry system now in use... or in 1970.

Write for DEI Bulletin TMR-21... or call:

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AND INDUSTRY

Defense Electronics, Inc.
Main Office:
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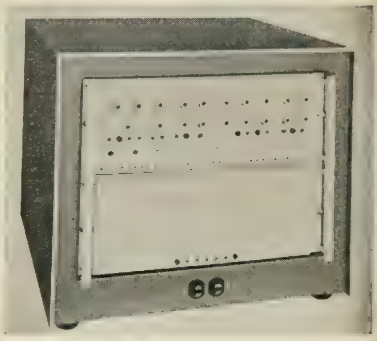
Rockville, Md. TWX: 301/949/6788
Regional Office: Sherman Oaks, Calif. Phone: 873-4322

Circle No 10 on Subscriber Service Card



erated: main frame identification; main frame special word; common word; subcommutation special word; and subcommutation identification. Special words may be inserted at any frame location. Main frame lengths are selectable, from 2 to 512 words. Subcommutation frame lengths are also selectable, from 2 to 128 words. Parity may be locked out or inserted at the end of each word. Subcommutation is provided for any word within the main frame.

Circle No. 229 on Subscriber Service Card

Miniature Cryogenic Cooler

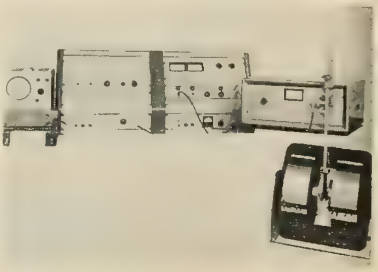
The Cryomite, a closed cycle refrigeration engine available from Malaker Laboratories, Inc., attains liquid nitrogen temperature in minutes in its single stage design. The design and configuration, with motor locations perpendicular to the drive shaft axis, will normally be confined to a 5 in. dia. and 6 in. length.

The air-cooled Model Mark VII features the drive motor in-line with the Cryomite. The overall weight is less than 14 lbs., and the length is 12¾ in. It has cascaded in two and three stages to temperatures below —200°C.

Circle No. 230 on Subscriber Service Card

X-Band Spectrometer

The X-Band Electron Paramagnetic Resonance Spectrometer is available from Alpha Scientific Laboratories.



The system operates at X-band (10 gc) and comes with a precision 6-in., 10-kilogauss magnet and matching regulated power supply with calibrated magnetic field sweep. The system is supplied with a 100-kc modulator, associated 100-kc phase detector and a graphic recorder. It can be used for both quantitative and qualitative analysis.

Circle No. 231 on Subscriber Service Card

Sylvania Develops CW Gas Laser

The Microwave Device Div. of Sylvania Electric Products, Inc., has developed a self-contained, sealed-off, CW (continuous wave output) gas laser.

Designated GL-6211, it features an all-quartz, sealed-off laser tube with Brewster angle windows and external optical system. Its operation does not require a vacuum station or gas filling equipment.

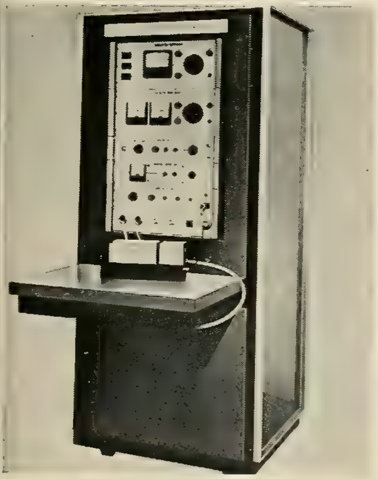
The GL-6211 operates in the following manner. The tube is filled with a gas mixture of helium and neon at a low pressure. A radio frequency field excites the atoms in the tube. Photons, or light, spontaneously emitted by some of the excited atoms, are reflected back into the excited gas mixture from 99% reflecting mirrors placed adjacent to both ends of the tube. These reflected photons stimulate neon atoms in the proper excited state which then emit additional photons precisely in phase with the stimulating photons.

The above photograph of Sylvania's new laser was erroneously identified in the Aug. 26 M/R as being RCA's gallium-arsenide injection laser.

Circle No. 233 on Subscriber Service Card

50-Megawatt Pulse Laser

Korad Corp., a subsidiary of Union Carbide Corp., has developed the K-1Q, a Kerr-cell-controlled laser with a minimum peak output power of 50 megawatts at room temperature. The pulse energy is 1 joule, rise time is 3 nanoseconds and pulse width is 5-20 nanoseconds. Beam width is 7 milliradians.

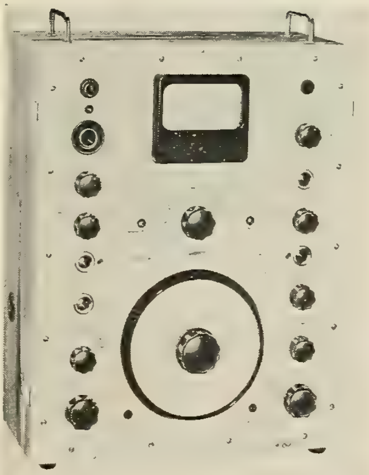


The K-1Q is a complete laser unit that may be operated manually or semiautomatically for experimental studies in optical radar, communications, radiation effects, metal working, photography, chemistry and non-linear optics. The K-1Q device can be converted for use as a 20-joule, 0.5-millisecond laser oscillator, or as an amplifier.

Circle No. 232 on Subscriber Service Card

Narrow Band Analyzer

Developed by B and K Instruments, Inc., and designed for analysis and linear measurements in mechanical, acoustical, and electronic research and production control, the Model 2107 is a narrow-band, audio-frequency analyzer of the constant percentage bandwidth type. It has six selectable filter bandwidths ranging from 6 to 29% of the center frequency, and continuously tunable from 20 to 20,000 cps. The instrument measures rms absolute average or instantaneous peak values of the input signal. The rms readout gives consistently accurate data for all types of signals—including sinusoidal, periodic, and random.



Applications of the device include frequency analysis, harmonic-distortion measurements, and automatic narrowband analysis.

Circle No. 234 on Subscriber Service Card

Code Generator/Reader

Available from the Electronic Engineering Co. is the 858 Time Code Generator/Reader, which combines the circuitry necessary for the generation of a time code for recording on magnetic tape and at the flip of a switch will read the code recorded on magnetic tape and display it on its front panel. The unit makes possible the combination of a magnetic tape reference device and readout unit on the same chassis. The 858 generates a modified IRIG code (format B less days) and in its reproduce mode displays hours, minutes and seconds in a range from 1/20 to 200 times record speed.

The 858 makes any analog tape deck into a complete time marking and manual search system. A visual analysis during playback is assisted because the unit permits the slowing down of the time code for recording on oscillographs or strip charts.

Circle No. 235 on Subscriber Service Card

Component Oven

Hi-G Inc. is offering precise proportional control of temperature in a component oven now available in units approximately the same size as ordinary thermostatic on/off types. The miniaturized PC-05 oven offers long-term temperature stability of ±0.05° C in a unit measuring only 2 in. high x 1¼ in. in diameter. Cavity space is 2 in.^{3}

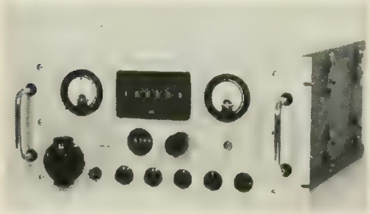
The PC-05 employs solid-state control circuitry and is designed to maintain customer prescribed temperatures up to 100° C within ±0.01° C. Temperature settings are available down to 15° C above expected ambient. Operating ambient environment temperature range is from —55° C to 15° C below oven temperature. Input is 28v dc with 1% regulation. Power requirement is 10 watts typical, depending upon thermal load, and approximately 2.5 watts after warmup.

The unit is completely self-contained. It may be used for components, circuitry, reference junctions, or any other equipment requiring tight temperature control and high density packaging.

Circle No. 236 on Subscriber Service Card

Calibration Signal Generators

A series of calibration signal generators for use in field operations as a secondary standard to calibrate and test both telemetry and tracking receivers has been developed by Defense Electronics, Inc.



The all-solid-state units, designated CSG, provide output frequencies in 1-kc steps across the 136 and 400-mc telemetry bands.

Capable of being phase- and amplitude-modulated over a wide video bandwidth, the devices allow for separate AM and PM modulating inputs providing the capability of three modulation modes: AM, PM, or simultaneous AM-PM. Modulation waveforms may be any complex wave form supplied by an external signal generator or tape recorder in the playback mode.

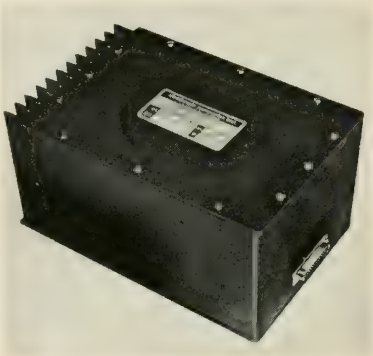
Output power may be accurately set to a fixed level and is highly stable with respect to time and temperature changes. The output level is continuously variable over a total range of 140 db, with an RF leakage below —155 dbm.

Circle No. 237 on Subscriber Service Card

Severe Environment Memory

Electronic Memories, Inc., is marketing a militarized, high-density, random-access core memory. Designated SEMS-1R, the memory has a 4.0-microsecond read/write time, will operate over a range of —55° to 100°C without current compensation, and contains 4096 words, up to 32 bits in length.

The SEMS-1R is available in two package configurations. The larger package has removable circuits to allow maximum field maintenance and repair. The smaller package has all subassemblies packaged in welded modules for maximum reliability.

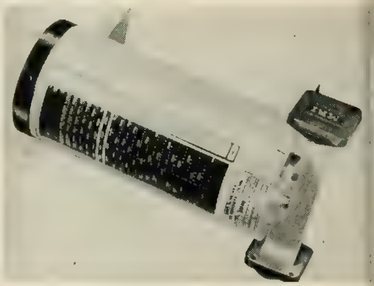


Circle No. 238 on Subscriber Service Card

Precision Frequency Meter

A precision frequency meter for laboratory or systems applications is available from Micro-Radionics, Inc.

Offering a frequency of 8.20 to 12.40 gc, the unit is a high-Q absorption type meter. It is constructed of invar filled with dry nitrogen and hermetically sealed to minimize frequency shift due to changes in humidity or temperature.

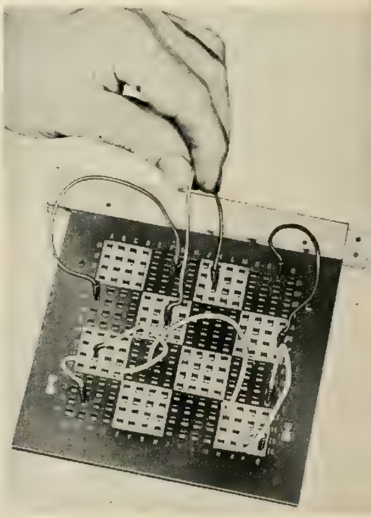


Typical specifications include: nominal Q, 8,000; accuracy, 0.015% (room temp.) and 0.03% (—40° to 55°C); flange type equivalent, UG39/U; nominal dip, 35%.

Circle No. 239 on Subscriber Service Card

Computer Programing System

A computer programing system has been developed by Oak Manufacturing Co. Called the Lockpatch Programing System, it is, in essence, a multi-contact, manually-operated switch, which consists of two insulated terminal boards (one fixed, the other removable), plug-in cords, and a hinged receiver which



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brings the two boards into contact.

Terminals of the fixed board are permanently connected to the internal circuits of the equipment. When certain information is to be fed into the equipment, plug-in jumper cords are inserted into the removable board in the proper pattern for that information. The removable board is then inserted into the system and locked into place against the fixed board. The Lockpatch terminals on the removable board make contact with those on the fixed board and switch the circuits into the predetermined pattern.

Circle No. 240 on Subscriber Service Card

Tape Recorder/Reproducer

American Concertone, Inc., a division of Astro-Science Corp., is marketing a miniature instrumentation tape recorder.

The Model TR-1875 tape recorder/reproducer is designed to operate under extreme shock and vibration environments encountered in missile and satellite launchings. It is used in an advanced data acquisition, recording and telemetry application.

Circle No. 241 on Subscriber Service Card

Time Code Generator

Developed by Electronic Engineering Co., EECO 807 Time Code Generator produces three timing codes for coordinating data in missile and satellite instrumentation.

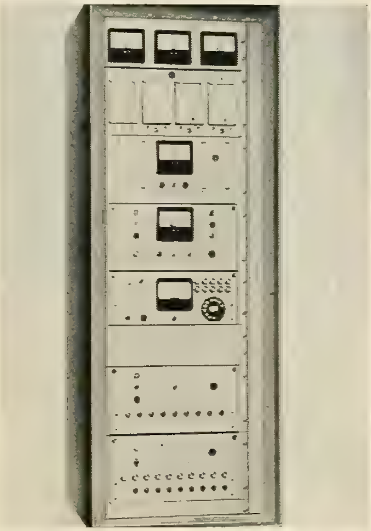
The three codes are available as dc level shift serial code and modulated serial code (AMR Designation: B_1-B_2, C_1-C_2, D_1-D_5). Pulse rates are available 100,000 pps, 10,000 pps, 1,000 pps, 100 pps, 20 pps, 10 pps, 1 pps. Time of day in hours, minutes and seconds is displayed on the front panel of the unit with incandescent lamps.

The internal crystal controlled 1-mc frequency standard maintains a stability of 5 x 10^{-9} per day at normal ambient operating temperatures. Stability is better than 3 x 10^{-8} per day over the temperature range of −20° to 55°C.

Circle No. 242 on Subscriber Service Card

Remote Control System

A method of controlling and supervising equipments operating at widely separated locations has been developed by General Electronic Laboratories. The Autolog Automatic Remote Control System combines remote control techniques with multiple chart recorders and automatic alarms. Its operation is based on telephone dialing. The simplicity of operation and modular construction allow the Autolog to be adapted to varying industrial control requirements.



Autolog may be used to control up to nine functions from a remote point while simultaneously observing on the chart recorders the result of the control function being performed. Any number of nine position systems can be added as needed.

Circle No. 243 on Subscriber Service Card

Solid-State Commutator

Dynaplex Corp. is marketing the Type 310 miniature High Level Commutator. The device is designed with silicon semiconductors and transistor switching gates for data inputs. Each solid-state commutator is furnished with internal line voltage regulator, clock, logic and appropriate switching circuits.

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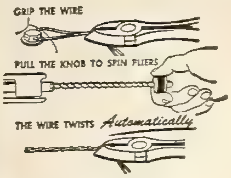


Write for details to

Ralph C. Robinson Co.

Dept. RM, P.O. Box 3494,
North Sacramento 15, California

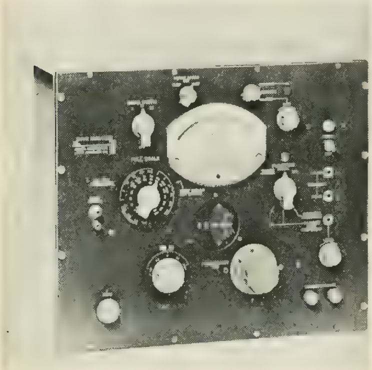
Circle No. 13 on Subscriber Service Card

ter than 0.25%; 0 to 5 volt signal input levels with over and negative voltage limiting; approximate current drain of 30 milliamperes at 28 + 4 dc volts and the availability of IRIG PAM formats for 30, 45, 60 or 90 channels with either positive or negative pedestals.

Circle No. 244 on Subscriber Service Card

Wave Analyzer

General Radio has available the Type 1900-A Wave Analyzer, a heterodyne voltmeter covering the frequency range from 20 cps to 50 kc, with the switch selection of 3-, 10-, or 50-cps bandwidth. Full scale voltage range is 30 μv to 300 v, with 1-megohm input impedance on all ranges.



100-kc and 1-ma dc outputs for recording, a restored-signal output at the frequency of the input signal, and a tracking analyzer sine wave output at the indicated center frequency are provided.

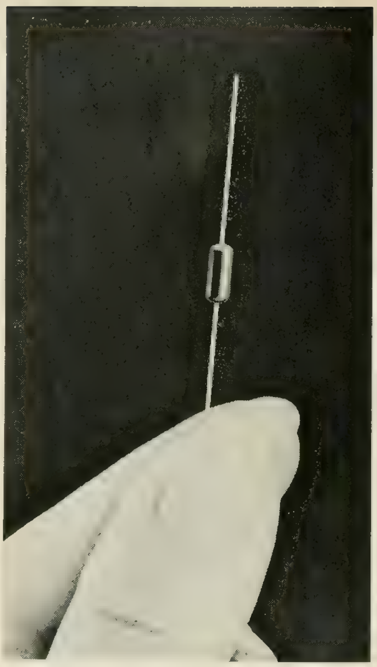
Circle No. 245 on Subscriber Service Card

High Temperature Thermistors

Model 4J100 (Composition J) has been designed by Thermonetics, Inc., for measurement and control applications in high temperature environments up to 500°C.

Ceramic, encapsulated with a hermetic seal and axial platinum leads, these thermistors are suited for use in corrosive fluids such as gyro oil, contaminated atmospheres, or wherever high temperature and corrosion are encountered and close ratio tolerances desired.

Standard electrical characteristics include: resistances at (25°C) from 10,000 to 50,000 ohms; resistance ratio $\frac{0°C}{50°C}$, 9.1 ±3%; beta (25° to 75°C), 3965°K ±55°K; temperature coefficient of resistance, —4.4% C; dissipation constant, 4mw/°C; time constant, 30 seconds; power (maximum), 2 watts; maximum operating temperature, 500°C.



Circle No. 246 on Subscriber Service Card

Time Delays

Two miniature time delay units have been developed by the Trimpot Div. of Bourns, Inc.

Each can provide delays from 0.1 to 15 seconds over a nominal voltage range of 20 to 30v dc with an external timing resistor. With the addition of an external capacitor, the total delay can be extended to 200 seconds.

The Model 3900, a DPDT time delay relay encased in a package measuring 0.4 x 0.8 x 1.3 in., employs an electromechanical relay capable of switching 1 ampere resistive at 26.5v dc. The Model 3907, a solid-state switch in a 0.4 x 0.8 x 1.0-in. case, features an internal SPNO solid-state device rated at 250 milliamperes resistive at 26.5v dc.

Circle No. 247 on Subscriber Service Card

Portable Relay Tester

Telegraph Relay Tester Model 7110, a self-contained portable unit, has been developed by the Products Div. of Radiation, Inc. The unit is specifically designed for rating the input and output characteristics, line current and voltage, and sampling level of Radiation's solid-state relays. With adapters, the unit's metered indications of performance are also obtainable on other neutral, polar and differential solid-state of electromechanical relays.

Variable input current allows the device to test relays' dc sensitivity utilizing internal source circuitry. Dynamic operational tests including biasing of differential relays are obtainable with external power by feeding pulse information into jacks provided on the front panel.

Circle No. 248 on Subscriber Service Card

Pulse Modulator

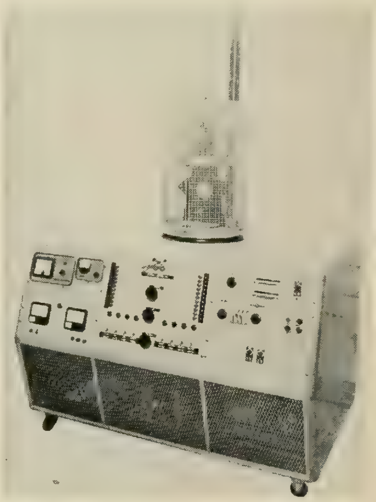
L P Associates, Inc. has available a Pulse Modulator, Model LP4500-1. The device provides pulses continuously variable from 30 ns to 10 μs and heater power for a large variety of low power magnetrons and other microwave tubes. It may also be used to modulate electron guns which have a control grid or anode.

The unit produces pulses in the 500 to 4,500-volt range at up to 3 amperes peak current. A soft tube (hydrogen thyratron) circuit is employed with the addition of a second thyratron to terminate the pulse.

Circle No. 249 on Subscriber Service Card

Orbital Simulator

Developed by General Design, Inc., an environmental test chamber for evaluating components, particularly electrically operated devices under imposed torque loads and with varying conditions of voltage and/or frequency, offers evacuation of 1 x 10^{-6} torr. Temperatures may be automatically cycled from —100° to 260°F, with temperature controlled to ±2°F after temperature stabilizes. Platen has 21 feedthrough connections to instrument panel for supplying power and monitoring specimen. Built-in dc power supply is variable from 0 to 40 volts and 0 to 10 amperes.



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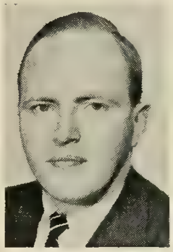
names in the news

ROSS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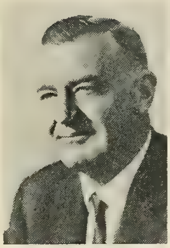
SPRAGUE

Francis L. Ross: Appointed western region marketing manager of the Flexprint Products Div., Sanders Associates, Inc., Nashua, N.H.

Renville H. McMann, Jr.: Promoted to vice president of the Military and Industrial Systems Dept., CBS Laboratories, Stamford, Conn.

John H. Cover, Jr.: Appointed director of advanced programs at the Aeronutronic Div., Philco Corp., Newport Beach, Calif.

Mansfield D. Sprague: Vice president of American Machine and Foundry Co., made deputy group executive of the Advanced Products Group, New York City.

Dan A. Kimball: Board Chairman of Aerojet-General Corp., named "Home Study Man of the Year for 1963" by International Correspondence Schools.

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Maj. Gen. Francis J. McMorrow: Commanding general of the U.S. Army Missile Command, Redstone Arsenal, Huntsville, Ala., died in the base hospital after suffering a heart attack Aug. 23. He had held his post since August, 1962. He was buried at the U.S. Military Academy, West Point, N.Y.

George A. Bronson, Dr. Stuart L. Ridgway and Dr. Donald J. Farmer: Elected vice presidents of General Technology Corp., Torrance, Calif.

Karl R. Wuensch: Named manufacturing manager of the Electronic Products Div. of Corning Glass Works, Raleigh, N.C.

Dr. Henry L. Richter, Jr.: Elected a vice president of Electro-Optical Systems, Inc., Pasadena, Calif. **Al M. Carnesciali** named associate manager of administrative services. **Richard N. Strong** named EOS contract administration manager.

Edward J. Heesacker: Appointed manager of the Space Booster Programming Div. at Thiokol Chemical Corp., Brigham City, Utah. **Carver Kennedy** appointed manager of the Space Booster Development Div.

Edward R. Lund: Appointed director of Burroughs Corp.'s Federal Government Activity, Washington, D.C.

Norman J. Regnier: Named vice president-marketing for RS Electronics Corp., Sunnyvale, Calif.

Dr. John D. Bledsoe: Appointed staff scientist for the United GeoMeasurements Div. of United ElectroDynamics, Inc., Pasadena, Calif.

Thomas Nast: Elected president and chief executive officer of Robinson Technical Products, Inc., Teterboro, N.J.

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A Need to Know

NOW THAT WE HAVE ACHIEVED a measure of success in whirling operational and developmental military hardware in orbit about the Earth, it is all too easy to neglect the spawning grounds for these promising systems—the basic and applied research laboratories and testing facilities of the nation.

The Air Force lately has taken a creditable interest in publicizing the more pedestrian areas which are the source of our amazing achievements in space. Last week, a group of technical newsmen was taken on a tour of the varied AF laboratories at Wright-Patterson AFB in Ohio. And in the September issue of *Armed Forces Management,* Gen. Bernard Schriever, chief of Air Force Systems Command, has penned a forceful plea for improved research, development and testing facilities.

Air Force efforts to call more attention to these relatively mundane but extremely important fields are indicative of some far-sighted thinking—thinking aimed at heading off developmental problems which still are five, eight or ten years ahead. The Air Force is not alone in this thinking.

Secretary of Defense McNamara said not long ago: "The Dept. of Defense must insure that these laboratories, which constitute one of our greatest assets, are properly supported and utilized."

Dr. Harold Brown, head of defense research and engineering, has pointed out that in many cases the department's laboratories are lagging behind government-supported industrial or university facilities in quality of physical plant. This, in turn, has a degrading effect on the caliber of scientific and engineering personnel which the military can attract to its laboratories.

Justification of research and testing facilities for weapon systems which are not even in sight is difficult in budget hearings. It is hard to condemn a Congressman for failing to see the need for money to support a system which the military cannot even visualize.

Yet, as Gen. Schriever points out, Air Force capabilities during the next five to ten years are inextricably tied to decisions made today on research, development and test facilities.

"These decisions, in large measure, will determine the ability of the Air Force to continue to meet the responsibilities for national security in the Space Age," he points out.

The AFSC commander makes a strong case for adequate long-range planning in this area.

"This is a matter of real urgency," he says, "because advanced laboratories, wind tunnels, environmental chambers, ranges and associated equipment are items with extremely long lead times."

As a reminder that today's weapon systems were developed in facilities conceived in the 1940's and built in the 1950's, Gen. Schriever turns to the engineering test cells at the Air Force Arnold Engineering Development Center (AEDC) in Tennessee.

Although these cells were designed in 1944-45—during World War II—to test aircraft engines, three of the seven are used exclusively today in the testing of rocket motors—not even a foreseeable part of a U.S. weapon system when the cells were conceived.

The need for a long lead time in planning is emphasized by the fact that these seven engine cells did not become totally operational until 1957—some 12 years after the first steps toward their acquisition.

Are such facilities really critical in the development of new systems? Again, Gen. Schriever cites some apt examples:

- When an advanced ICBM failed at Cape Canaveral, films of the launch indicated the failure originated in the vehicle's base, but telemetry data failed to show the cause. A scale model of the missile was constructed and placed in an altitude test cell at AEDC, where it was found that hot exhaust gases, recirculating in the base of the missile, caused the launch failure. The Air Force found that this problem was common to several other advanced missile and booster systems, and thus averted further expensive failures.
- After a rocket motor failed in orbit, despite a perfect test record at sea-level conditions, the motor was tested under simulated flight conditions at AEDC. This quickly turned up the cause of failure.
- Sled tests of the *Minuteman* guidance system at the Central Inertial Guidance Test Facility, Holloman AFB, N.M., uncovered three specific defects—any one of which could have caused the loss of a missile. With necessary corrections, the guidance system worked flawlessly on the very first *Minuteman* shot at Cape Canaveral.

Gen. Schriever points out that the Air Force facilities at Arnold, conceived in the '40's, have supported nearly every major military missile and space program of all three services, as well as the *Mercury* and *Apollo* manned spaceflight programs of the National Aeronautics and Space Administration.

The AFSC commander notes that lead time on design and construction of a complicated state-of-the-art facility may be as much as eight years—to which must be added the two or more years required between its initiation and receipt of funding.

TO HELP EASE the problem facing Congress in making decisions in this difficult area, Dept. of Defense has improved its facility acquisition procedures. Beginning with the FY '64 budget, technical facilities are submitted separately from other construction items.

"A recognized element of risk is involved in acquiring new facilities, as there is in any urgent military program," Gen. Schriever concedes. "But the need for technical facilities more than justifies the risk involved, in view of the alternatives. A decisive Soviet lead in space technology and military spacepower would be disastrous for the Free World. The United States cannot afford to neglect the requirements of technological progress."

We hope Congress will remember these words and give close attention to the technical requirements outlined by the military as it considers this extremely nebulous but very important area.

William J. Coughlin

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 11 September 9, 1963

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THE COVER

Close-up of precision tracking mount recently installed at Pacific Missile Range for photographing missiles during launch phase. Developer AMF claims mount can slew quickly enough to track a rocket sled and slowly enough to watch an orbiting satellite. See p. 26.

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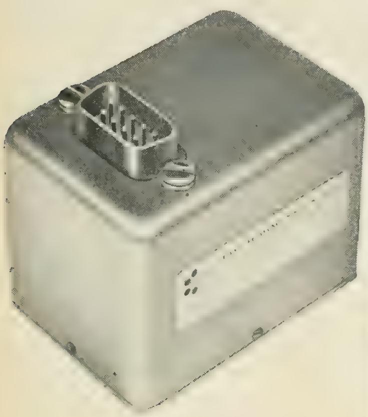
PULSE/LOCK*



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letters

Boston Center Rebuttal

To the Editor:

Your Aug. 5 editorial ("Something for Boston") offends me as a son of Massachusetts and a longtime worker in the aerospace industry. It is apparent that you feel that any Administration decisions affecting Massachusetts should be given the closest scrutiny because our junior senator happens to be the President's brother. This impugns the character of the President, the Senator and those NASA officials responsible in this area of interest. I don't believe the Senator's campaign slogan is any more susceptible to scrutiny than the average campaign slogan. Just think about some of the others you've heard.

Your editorial questions both the need and the proposed site for the electronics center. The need should be apparent to anyone close to the space business. I need only recount the sad story of the *Ranger* series and the on-again/off-again performance of our various communications satellites to point out the presently marginal status of electronic components and systems in the space environment. Electronics developments just have not kept pace with progress in propulsion, aerodynamics, inertial guidance and many other aspects of space technology. The Cooper flight was another example of man having to override an automated electronic system. As the space effort advances, more and more pressure will be placed on reliable electronic systems.

As for the site—why not Boston? In the crisis atmosphere of World War II, the nation turned to MIT and Harvard to pick up the pieces of radar development and turn them into an integrated program. The achievements of the Radiation Laboratory and the Cruft Laboratory certainly changed the course of the war. The electronics industry around Boston stemmed from this initial impetus. The Lincoln Laboratory of MIT responded similarly to the air defense needs of the Fifties. I believe a crash program in electronics research is essential to the space effort. Apparently NASA agrees and is confident that this area will deliver as handsomely as it has in past crises.

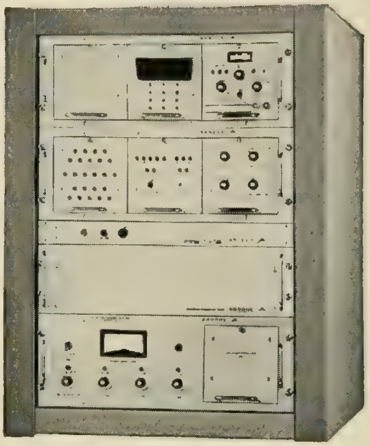
To sum up, I believe your suspicions of a Kennedy deal have affected your usual technical objectivity. The need is real and Boston would be an excellent site for the electronics center. Furthermore, anyone who thinks that Ted Kennedy needs this center to insure his political future is just not familiar with Massachusetts politics. The Kennedys could win here if they advocated putting the center in Leningrad.

Michael A. Walker
Sudbury, Mass.

Selling Space

To the Editor:

In your July 15 editorial ("A Message to Company Presidents") on how the public can be sold on the space program, you



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answered your own question when you said it benefits the nation and the industry.

Please permit me to suggest the printing of pamphlets with modified material contained in the Government's publication, *Space, the New Frontier,* by NASA (price 35¢) and distribution of it free to the public, attached to their pay checks.

I believe this will change the picture of the space program.

E. N. Cayafas, Pres.
Percentage Training Service
San Carlos, Calif.

Personnel Runaround

To the Editor:

This is a plea for a more enlightened (and enlightening) policy on the part of personnel departments.

The situation is this: My husband, through no fault of his, was laid off three months ago. His company has decided to get out of the defense business. I'm sure our predicament is far from unique.

Since then he has travelled literally thousands of miles, and I have written well over a hundred letters of inquiry, in the process of job-hunting. There is no fault to find with the answers to the letters we sent out "blind," not knowing whether or not an opening existed. Most were very prompt, courteous and practically all commented on my husband's impressive qualifications.

Here a curious contradiction arises. He has answered ads listing the very qualifications and experience he possesses; the answer to these is that he "does not possess the qualifications we are looking for," etc. Never once have there been any particulars given. Apparently this would violate some unwritten law governing personnel offices.

Exactly two answers out of the hundred-plus made positive suggestions, and to these two personnel people our eternal gratitude. One actually gave the name and address of another company which might be hiring. The other mentioned that the résumé was being sent to another division of the company (in another state), since the qualifications were so outstanding. There seems to be virtually no liaison among the scattered divisions of the same company. This seems most inefficient, and we wonder why it is so.

Another variation goes like this: A company expresses interest and says he will hear after they have had an opportunity to "review his qualifications." Weeks go by, sometimes months. A month in the life of a company is no doubt "as the twinkling of an eye." In the life of a family without an income it is an eternity. The only thing that has stopped coming is the paycheck. Bills continue coming in; people still get hungry; shoes wear out. Is all this delay really necessary, or is it sheer inefficiency?

Perhaps I should have mentioned before this that my husband has just passed fifty. Some of you personnel men who may be reading this will suddenly remember that you are out of cigarettes, or that the steak you are grilling is about to burn. There seems to be a conspiracy to consign men over 45 to a kind of limbo until they are old enough to collect Social Security.

Will it come to the point where men over 45 will have to stage sit-ins, lie down on the sidewalk outside your plants, and otherwise make themselves obnoxious, before they receive justice? They still have much to offer in the way of knowledge, maturity and loyalty. They are willing to make adjustments on, or even forego, retirement benefits, etc. They are old enough to know that "security," as we speak of it today, is a very illusory thing, not to be purchased in dollars and cents or in fringe benefits.

Our children are wondering whether their father will get a job offer so that we can move before school starts. (Yes, many men over fifty are still raising families.)

Just what *is* the score in the "personnel game," gentlemen?

Name Withheld on Request
Winston-Salem, N.C.

Hand Spectroscopes

To the Editor:

In regard to speculations in your July 8 issue that astronauts might study planetary emission spectra (colors) and changes in "color" as the planets are occulted by the ionosphere, moonset, and red arcs by making crayon drawings, I suggest that consideration be given to small hand spectroscopes, which might simultaneously afford the advantages of the high color sensitivity of the human eye and the precision of a scientific observation, especially if the observer knew the prominent features of the spectra involved and carefully noted changes in relative brightness between features. Hand spectroscopes are light and easy to operate.

Daniel Payne Hale, Ph.D.
Nuclear and Plasma Physics Branch
Research Projects Division
Marshall Space Flight Center
Huntsville, Ala.

No News Like New News

To the Editor:

Your magazine is very informative and serves as an excellent source of news of current activities in the space field. As a graduate student who will be going into the academic world as a cosmochemist, I find that many of your articles contain important data that I might not read in the professional journals until several months later. Several other scientists that I know also read your magazine, and I think we all hope that there will continue to be more academically oriented articles—such as discussions of proposed experiments, current experiments, and results of experiments carried out on the various satellites and probes. Scientific journals often report only the experiments that have been completed, and a detailed discussion of experiments before they are run could be advantageous to everyone. As a minimum, it would be a great service to hear the results of these experiments as soon as possible.

John L. Barker, Jr.
Chicago

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issue: october 7, 1963 **advertising closing: september 23**

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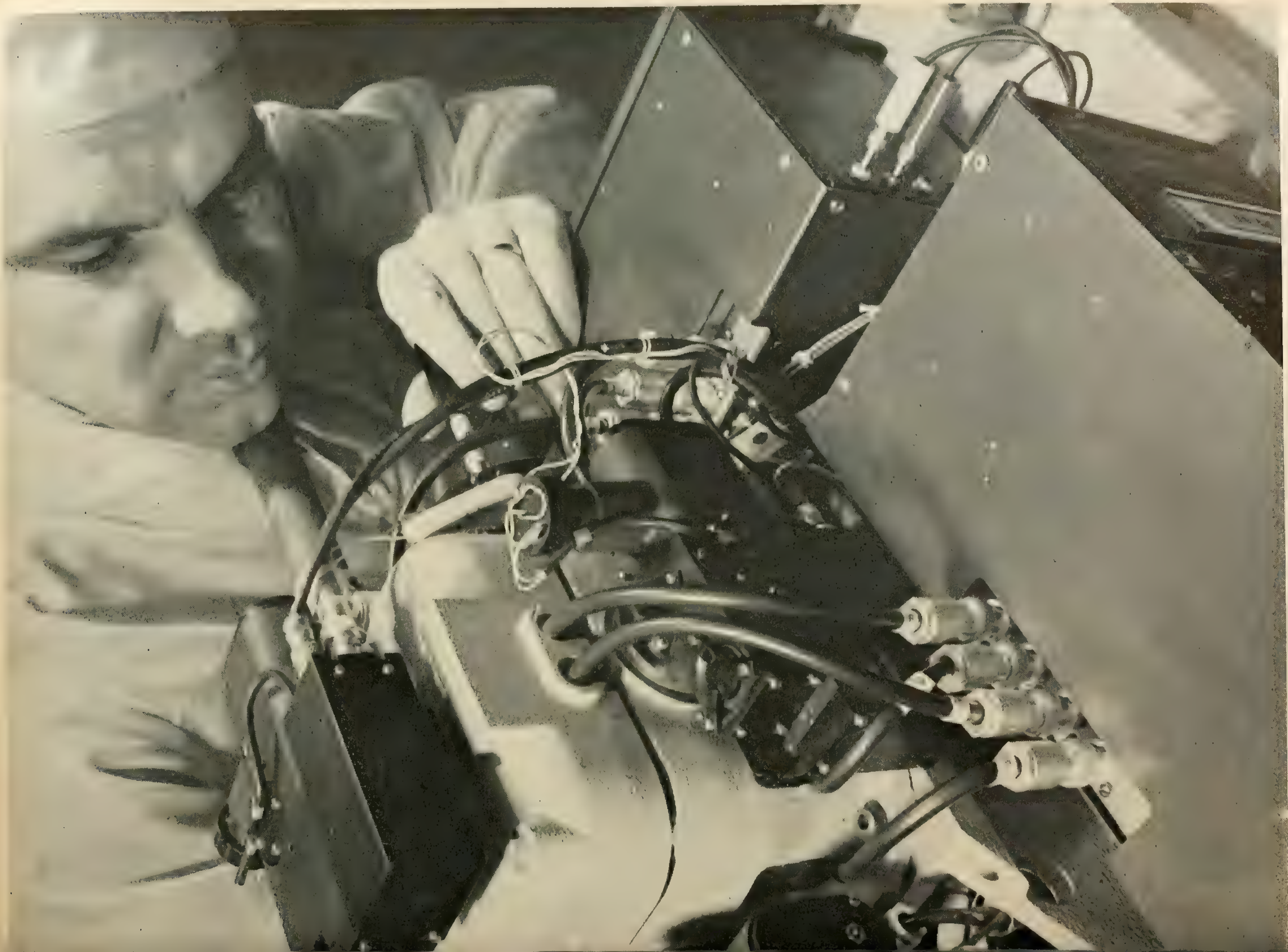

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The Countdown

WASHINGTON

HIBEX Study Contract to be Awarded

Pentagon was ready last week to award a conceptual study contract in the HIBEX (high-impulse booster experiments) portion of the anti-ballistic missile *Defender* program. Front-runners in the Advanced Research Projects Agency competition were Lockheed and Boeing.

Space Station Simulator Funded

Manned Spacecraft Center has initiated the first hardware fabrication for a space station simulation facility which it plans to start using early next year. The Center has kicked off funding with a $30,500 contract to Whirlpool Corp. for design and development of a feeding system for four astronauts for long periods of time.

Orbiter May Become Pathfinder

One of the names being considered for the space agency's new lunar orbiting photographic spacecraft (see p. 17), formerly called *Surveyor Orbiter,* is *Pathfinder.* Final decision will be made by a special NASA committee established to name new space agency projects.

MMRBM Still Considered Dead

One influential Senator believes the *Mobile Medium Range Ballistic Missile* project is as dead as ever—despite the plea for its revival by the Joint Chiefs of Staff. He sees the JCS support as an exercise by Dept. of Defense to prove that the Joint Chiefs really do have freedom of speech before Congress.

Manned Apollo Flight Could Come in 1965

Earliest possible date for the first manned *Apollo* flight with the command and service modules boosted by the *Saturn I* now is considered to be the fourth quarter of 1965. Slippage into 1966 is likely, however. First test flight of the *Saturn V* moon rocket is December, 1966—about a year behind schedule—with six unmanned flights set for the series. First manned *Apollo* flight with *Saturn V* may not be attempted until 1968—still the target date for the first manned lunar landing—a target that is becoming less likely by the month.

Air Force Still Active in Gemini Program

Top Administration officials report that there is no basis for belief that Air Force will be ruled out of participation in actual manned flights with the *Gemini* spacecraft simply because it is limited to piggyback flights of military experiments in Fiscal '64. They point out that funds for AF spacecraft would be needed in Fiscal '65—not Fiscal '64. Joint NASA-DOD *Gemini* board, however, still has not recommended any plan calling for AF orbital flights. The board has studied use of *Gemini* with *Titan III* for this purpose.

Centaur Plans Await Fluorine Review

The push within the Office of Space Sciences for a fluorine upper stage with 40,000 lbs. thrust is putting into abeyance plans for *Titan-Centaur* or an uprated *Atlas-Centaur*—at least until a decision on the new stage is made. Launch vehicle experts in the office want to go ahead with the new stage, which they say could explore 90% of the solar system in combination with *Thor* and *Titan* boosters (M/R, Sept. 2, p. 14).

NOSS Decision Expected Soon

Word on the future of the *National Orbiting Space Station* is expected shortly, according to a high Dept. of Defense source. He declined, however, to elaborate on his definition of "shortly." A decision on study contracts for the Air Force proposal has been in the works for weeks.

Pricetag of Saturn V Flight with Apollo

A top NASA official recently gave Congress this estimate of the cost of a single *Saturn V* launching with an *Apollo* spacecraft: between $100 million and $150 million. NASA plans to fly seven to 10 *Saturns* before declaring the booster operational.

INDUSTRY

NASA Sets Out to Justify Electronics Center

NASA is starting an in-house study group to provide justification for the agency's proposed Electronics Research Center in Boston. Actual preparation of the document may be done outside on a contract basis, however. The study was ordered by Congress, which said it would release $3.2 million authorized for the center if NASA could justify its need and location.

Marquardt Develops Self-Consuming Rocket

Marquardt Corp. is at work on a rocket that would consume itself after launch so that only harmless pieces or ashes would fall to Earth. This is to enable use of sounding rockets at airports and other locations where launchings now are impossible. The company will submit a proposal on this to Air Force, NASA and Navy before year's end.

Commercial Technology Is Top NASA Fallout

A NASA-sponsored study of the commercial application of the missile/space program has found that the most important contribution has been the transfer of technology—not actual new product development, as believed earlier. The study identified 33 broad technological areas which have benefited from the space program.

NASA Sets Up Manned Space Sciences Group

NASA has established a manned space sciences division within its Office of Space Sciences. The new division will be equally responsive to the Office of Manned Space Flight, with most of its activities centered around the selection of experiments for manned space flight missions and designation of criteria for selection of scientist/astronauts.

INTERNATIONAL

South Africa Shows Missile Interest

South Africa is said to be seeking scientists and engineers experienced in rocket development. Reliable sources in Pretoria say the government is recruiting qualified personnel to produce rockets with conventional warheads. Especially sought are physicists and electronic and mechanical engineers.

With Apologies to Anita Loos

Diplomats in NATO nations are taking due note of the nationalistic French missile development with this comment: *"Diamants* are De Gaulle's best friend."

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The Missile/Space Week

P&W Fires H_2 Engine

Successful test firing of a small, high-pressure hydrogen engine using a novel cooling system may pave the way toward higher specific impulses in smaller powerplants in hydrogen-fueled vehicles.

Engineers at Pratt & Whitney Aircraft's Florida Research and Development Center fired a scale model of a cooled, hydrogen rocket chamber at chamber pressures higher than that used in current engines. The cooling technique involved was not disclosed but the milk-bottle-sized chamber generated 11,000 lbs. thrust.

The cooling demonstration is considered a breakthrough by the United Aircraft division in achieving high pressure combustion—considered the next step in increasing the performance of hydrogen-fueled engines. The high-pressure activity at P&W complements exploratory technology sponsored by the Air Force's Rocket Test Center at Edwards AFB.

NASA, DOD in Launch Pact

NASA and DOD have signed an agreement permitting the space agency to conduct launch operations for its missions using the *Atlas-Agena* or *Thor-Agena* boosters.

The agreement—which supersedes a February, 1961, pact—provides that the Air Force is responsible for design, engineering and acceptance testing for the *Atlas*, *Thor* and *Agena-D vehicles*. These will be procured by NASA from the Air Force.

The space agency will be responsible for mission modifications to the basic vehicles, including the shroud, adapter and spacecraft/launch vehicle integration for which NASA will make direct procurement with contractors.

Under the earlier agreement, the Air Force launched all *Atlas-Agena* and *Thor-Agena* missions for the space agency. In giving NASA this responsibility, the agreement provides that NASA will use Launch Complex 12 at Cape Canaveral. Air Force missions will continue to use Complexes 13 and 14.

The Air Force will continue to have responsibility for all *Agena* launches from the Pacific Missile Range—primarily because only a few space agency *Agena* missions are scheduled from there.

Atlas-Agena Gemini missions are not included in the new agreement because they are covered by the NASA-DOD *Gemini* pact.

X-20 Continuation Seen

Many working-level technical people in Defense Department Research and Engineering think that Secretary of Defense McNamara has finally decided to proceed with further *Dyna-Soar* development. Lending credence to the idea is the fact that the time is past when cancellation would have been psychologically opportune. The logical time to have killed the program would have been in July, at the turn of the fiscal year.

Reorganization at MSFC

A major reorganization at the Marshall Space Flight Center has resulted in establishment of a new division to consolidate all industrial project management activities and place increased emphasis on relations with major contractors.

At the same time, a new Research Development Operations Division has been formed to handle the Center's R & D activities.

The Industrial Operations Division will be headed by Robert B. Young. Hans Hueter, currently head of Special Assignments Office, will become Young's deputy effective Oct. 1. The division will include the portion of the Center's work performed by prime contractors—mainly the development of stages and engines for the *Saturn I*, *Saturn IB* and *Saturn V* boosters.

It will also have the offices of contracts, facilities projects, Project Logistics, and Resource Management.

The R & D Operations division will include the center's nine technical offices, Aero-astrodynamics, Astrionics, Computation, Manufacturing Engineering, Research Projects, Propulsion and Vehicle Engineering, Quality Assurance and Reliability, Test, and Launch Vehicle Operations.

It will also include four other offices, Future Projects, Special Assignments, Systems and Resources Management.

Raborn Joins Aerojet

Aerojet-General Corp.'s new vice president-program management, is Vice Adm. William F. Raborn, Jr., USN (Ret.).

Adm. Raborn retired recently

ter 39 years of service, and is rec- nized as one of the nation's leadg management authorities.

As first director of the Navy's pecial Projects Office, he headed a nique task force developing tech- iques that led to establishment of e *Polaris* fleet ballistic missile as n operational system years ahead f schedule.

hots of the Week

Reflecting increased U.S. em- hasis on perfecting an anti-missile nissile, the Army's *Nike-Zeus* on Aug. 30 scored the third successful CBM intercept in less than a week. The latest *Zeus*, fired from Kwajalein Island, scored its ninth "hit" on an Air Force *Atlas.*

Other shots of the week:

- An Air Force Strategic Air Command crew launched a *Minuteman* solid-fuel ICBM from a Vandenberg AFB, Calif., silo Aug. 29 on a 5,000-mi. trip down the Pacific Missile Range.
- Also from Vandenberg on the 29th, the Air Force fired a *Thor-Agena* carrying a secret satellite. The rocket combination, often used in launching satellites of the *Discoverer* series, was sent aloft by an Air Force Systems Command crew.
- The Navy launched a *Polaris A3* from a Cape Canaveral land pad Aug. 30 in a night flight to gather data on guidance, propulsion, and thrust vector control and to evaluate re-entry body flight dynamics. Flight was said to have been a success.
- The Air Force successfully fired a *Titan I* ICBM from Vandenberg, Aug. 30. The missile carried a mock nuclear warhead into a target area some 5,000 miles out in the Pacific.

Redstone to Hire 575

The U.S. Army Missile Command at Redstone Arsenal has started a program to fill 575 new jobs that will materialize before June 30, 1964.

More than 500 of the jobs will be created at the arsenal in Huntsville, Ala., and the remainder will be at missile test sites and operational missile units in the United States and abroad.

Economical Booster Developed

A booster designed to orbit payloads weighing 25 to 100 lbs. has been developed by Cubic Corp., San Diego, Calif. Total cost per firing using the *Forester* is said to be less than $500,000.

The off-the-shelf four-stage solid-propellant vehicle is complete with integrated electronic system for range safety, guidance, tracking and telemetry.

Interest in *Forester,* developed in conjunction with Thiokol Chemical Corp., has been expressed by Japanese, U.S. and European space groups, Cubic officials say.

Gemini Complex Bids Asked

The Army Corps of Engineers has called for bids to be opened Sept. 24 in the Canaveral District office for alterations to *Atlas* Launch Complex 14 for use by the *Atlas-Agena* in support of Project *Gemini.* Estimated cost of the work is $800,000.

NASA Gets Navy Ship

The U.S. Navy has turned over to the Marshall Space Flight Center a vessel which will be modified to carry the *Saturn V* Moon rocket booster.

MSFC will shortly award a contract for conversion of the vessel, which is still docked at Orange, Tex., with a naval reserve fleet.

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M-2 Flight Successes Spur Interest in Lift Re-entry

Public landings marred only by lateral wobbling, which is believed easily correctable; FRC director Bikle would move on to transonic investigation

by Russell Hawkes

EDWARDS AFB, CALIF.—Quickening of NASA interest in lifting re-entry shapes for orbital ferries was marked here by the first public flights of Flight Research Center's *M-2* lifting-body research glider.

Twice on Sept. 2 the wingless, plywood glider, designed for low-speed flight research, was towed to an altitude of 13,000 ft. by a C-47 and guided to a safe landing by test pilot Milton O. Thompson. Both times the steep glide to the dry lake bed was completed in a few seconds over three minutes. Despite the spectacular rate and angle of descent, Thompson landed smoothly one time and bounced only slightly the next when he touched down with excess speed.

He reported that the *M-2* glider handles much like a conventional airplane—except for poor lateral stability. During the climb to altitude, a MISSILES AND ROCKETS editor in a chase plane could observe the occasional waggling of the elevons and the 1 cps rocking of the glider as Thompson attempted to damp disturbances. This lateral touchiness is characteristic of wingless and short-winged aircraft, since all their mass is concentrated near the centerline of the vehicle. Addition of a roll damper to cure the deficiency, FRC engineers are convinced, would give *M-2* the easy handling qualities needed by astronauts exhausted by a prolonged mission in space.

- **Varied approaches**—The low-cost *M-2* program at FRC has stimulated new attention to the whole subject of re-entry shapes for manned spacecraft in industry and at the other NASA research centers. Proponents of other shapes are eager to see them embodied in an FRC glider and some wind-tunnel researchers have stepped up the pace of their work to formulate new problems for the FRC staff.

Variable geometry to accommodate the different stresses of re-entry and low-speed flight is being considered in a number of competitive concepts. One idea being studied at Ames Research Center is the addition of inflatable stub wings low on the sides of the *M-2* shape to improve the glide ratio. Another is the pyramidal *M-1* shape, which requires an inflatable afterbody to make it flyable. Ames researchers plan an attempt to inflate an afterbody on an *M-1* under simulated flight conditions in a wind tunnel. One afterbody has been fabricated for Ames, but it was inadvertently exploded during a test.

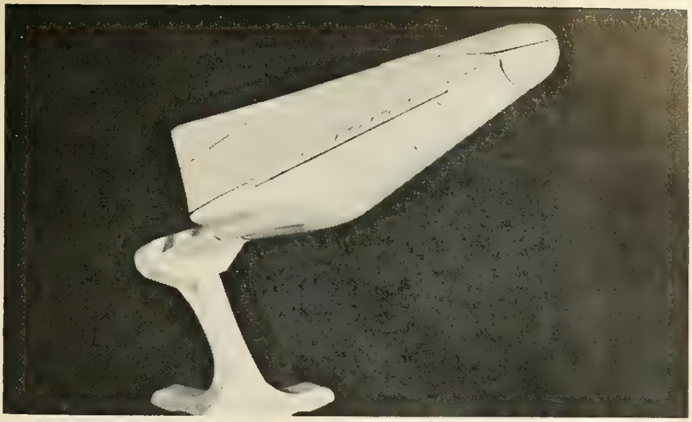
All the variable geometry designs face the difficult problem of deployment when the vehicle is already in flight and subjected to an aerodynamic load. The most extreme instance of this is the *M-3* shape (see photos, p. 15), which has folding delta wings. During re-entry, it has approximately the *M-2* shape and after the heat pulse is passed, the wings can be extended to make it an acceptable airplane. Actuators for this purpose have not been specified as yet.

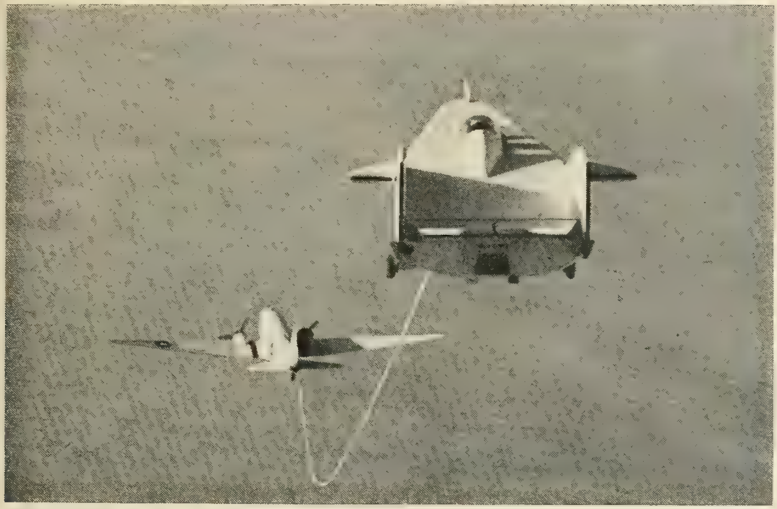
Models of *M-3* at Ames include an air-breathing engine, protected by a heat shielding inlet plug which is jettisoned after re-entry. A shape which is attracting less interest than it did a few months ago is Langley Research Center's lenticular vehicle. A more promising contender is Langley's delta-bodied HL-10 shape, which is quite likely to be embodied in FRC's next lightweight glider. A cardboard mock-up of it is taking shape on the hangar floor at Edwards.

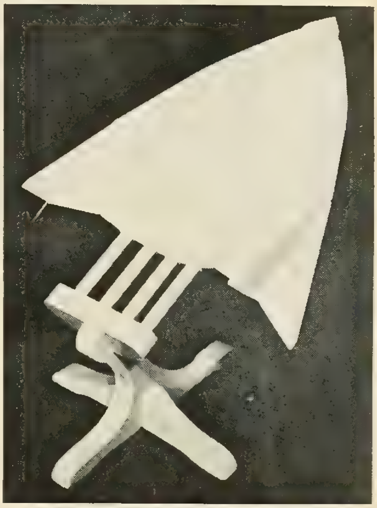
- **Moving ahead**—Now that his low-cost, lightweight glider approach to the study of re-entry spacecraft has been widely accepted, FRC director Paul Bikle has concluded that it is reaching the end of its usefulness. With a successful *M-2* program to show that lifting bodies can be landed safely by a human pilot, Bikle would skip the low-speed testing of many other lifting body shapes (M/R, Feb. 11, p. 26) and proceed directly to an investigation of transonic characteristics of lifting bodies.

This would necessarily be a far more expensive project than the present *M-2* program. It would require an aluminum full-weight vehicle to be air-dropped from a B-52, like the *X-15*, and accelerated through Mach 1 by a rocket propulsion system before gliding to a landing on the lake bed.

FRC has been warned that if such a program is attempted, it must be completed with a total expenditure of less than $1 million. No more funds will be available. Many experienced officials are convinced that it can't be done at







TOP LEFT: Wingless M-2 piloted by NASA's Milton O. Thompson starts takeoff run towed by C-47. BOTTOM LEFT: Glider is towed to 13,000 ft. altitude over Rogers Dry Lake Bed in one of two Sept. 2 flights (M/R photo). TOP RIGHT: Model at Ames Research Center shows M-3 re-entry shape with wings folded and heat shield plugs in place over air-breathing engine inlet and cockpit. Here it resembles M-2. BOTTOM RIGHT: With wings extended for maneuverability, M-3 suggests Dyna-Soar.

that price, but engineers are being shifted from the *M-2* program to a study ways of doing it. One money-saving idea is to purchase complete systems off-the-shelf or surplus. For instance, the entire control system and the stability augmentation system of an F-104 might very well be adapted for the full-weight lifting body research vehicle.

The seven *M-2* glider flights from altitude and the approximately 70 truck-towed flights to very low altitudes conducted to date have been mainly to assure that the vehicle is at least flyable and to give Thompson some experience with it. In the next few months, 15 or 20 flights will be made to collect detailed engineering data.

By the time these are completed, FRC engineers expect to have all the latest ideas of Dr. Alfred Eggers of Ames. Eggers conceived the *M-2* shape and a number of the others now under discussion. After the glider has been modified to incorporate the latest thinking, there would be another 8 or 10 flights, according to present thinking.

• **Alterations**—Among the planned modifications are these:

—Relocation of the cockpit further forward in the nose to improve the pilot's visibility. At present, he must judge his final landing approach by looking out a little window in the nose at the end of a tunnel. Ballast would be added to compensate for the weight shift.

—Removal of the elevons mounted high and outboard on the vertical fins. Protecting these from re-entry heating would be difficult and elevons on the aft end of the body should be adequate if their hinge lines are canted so that the yaw forces they produce are favorable.

—Extension of the aft end of the body a few feet. This is expected to reduce drag and eliminate a burble that is now corrected by flow turning vanes under the rudders.

Part of the early test program will be devoted to measuring the best glide angles possible with the boat-shaped glider and evaluating its behavior at high angles of attack. For safety's sake, past flights have been made at speeds faster than the 72 kts. which analysis indicates should yield the best glide ratio. Thompson has been losing a foot of altitude for every two feet of forward travel. At the best speed, he should be able to do 60% better.

The glider is fairly near the actual size of a 12-man orbital ferry. Designers calculate that the *M-2* ferry would be 28 ft. long, compared to the 20-ft. length of the FRC glider. ■

During FY '64 . . .

AF To Begin Work on Master Guidance System

THE AIR FORCE before the end of this fiscal year will embark on program definition of what is potentially the largest single space guidance system development ever initiated within the Department of Defense.

DOD has approved the Air Force's initiation of the first phase of a sequential, two-phase, funded program definition for a standardized space guidance system (SSGS). This is aimed at developing a single system capable of providing guidance and control for the launch vehicle, for orbital injection, and for actual spacecraft mission performance.

In effect, this is an attempt to do with guidance what the military, in the *Titan III* project, has already initiated in development of standardized space boosters.

The Air Force's Space Systems Div. is expected to issue RFP's before the end of FY '64. The Air Force "will probably invite every conceivable organization to bid which, based on past performance, we feel can do the job."

First phase of the program will be analytical, studying the various missions and translating the trajectories into hardware requirements. Phase 2, which will require separate approval based on Phase 1 findings, will investigate the means to turn these concepts into hardware. The total program definition phase (PDP) effort will last about one year.

In order to adequately fund contractors, the Air Force probably will select only about four firms to do the initial PDP work. These firms, which face a narrowing-down process, would be logical choices for the Phase 2 effort as well, if the latter is approved. Though SSGS could mean significant business for a few major firms, operational hardware development would no doubt involve a multitude of suppliers.

- **Titan III compatibility sought**—SSGS is actually an outgrowth of the *Titan III* PDP, and, if SSGS proves feasible and is developed, it could fulfill guidance requirements on later-block *Titan III's* replacing the modified *Titan II* guidance now used, while also providing G&C capability for a wide range of military payloads which could ride atop the booster. Compatibility with *Titan III* will be a major requirement.

System capabilities would be very broad, officials stress, encompassing satellite inspection and rendezvous missions in addition to other roles. Development of this concept within DOD and Air Force, and the decision to go ahead with at least the beginning of the PDP, was the product of a long-term separate effort. But it no doubt was influenced by realization of the high costs of turning out an operational guidance systems for projects such as the Air Force's *SAINT* program, now reoriented with the guidance effort shelved (M/R, Sept. 2, p 9).

NASA has been kept posted on the in-house progress in the SSGS project, and will continue to be informed of developments. The space agency has also been invited to comment on development, especially as to how this system can be expanded into a broader role. The degree of actual NASA participation in development has not yet been determined; this is one of the items now under consideration.

- **Seeking many ideas**—The Air Force expects to look at a wide range of guidance and control schemes, with trade-off decisions a key factor in early program definition. Though there are no initial constraints on G&C arrangement with respect to system types, there are very definite operational and design goals.

For example, the military will require a self-contained system, one which can operate with ground data links if needed but one that "is not inevitably tied to a ground link." For this reason, stellar-inertial type systems, combined with horizon scanners plus terminal sensors such as radar for rendezvous, may get a hard look.

A wide range of gyros, accelerometers, stellar systems, horizon scanners, radar schemes and ground data links probably will be investigated. More exotic guidance devices, such as laser ranging systems, are not likely to get early system consideration. They do not fall within the expected Air Force requirement for system components which have been through enough engineering tests so that performance and reliability are well known. The system is also expected to take a modular design approach, so that, for certain missions where particular sensors are not required, the unit could easily be removed.

With respect to control system design, planners point out that control system sensor instrumentation is of much more concern than the actual force-generating system. Close attention is expected in selection of these devices.

Savings produced by a workable SSGS would be very significant, DOD officials note. "We would be able to use the same parts over and over again in many different spacecraft. This is in sharp contrast to investing heavily in individual systems which may go aboard only five spacecraft of a particular series." Using individual guidance systems in individual flights has also limited collection of reliability data. ■

U.S. Command System Work Stepped Up

THE PACE QUICKENED last week in the top-priority National Military Command System (NMCS) program, whose evolution is DOD's answer to the pressing demand for a more responsive, flexible and survivable system of global military command and control.

Word came that the Mitre Corp. is expected to open a Washington office within about 60 days to assist the Defense Communications Agency in meeting stiff DOD deadlines for initial planning. Mitre will aid DCA in systems design, integration, interface and other phases.

The agreement with Mitre is expected to involve somewhere between $500,000 and $1 million in DCA funds during Fiscal Year 1964. DCA is reporting directly to DDR&E in the emerging program.

General requirements laid down by Joint Chiefs of Staff planners call for a system which will transmit, store, collate, retrieve and read out the array of information national commanders would need for decisions in every type of war.

NMCS, still highly classified, will absorb a number of communications and control projects currently under other roofs, including two projects in the Air Force.

Secretary of Defense Robert S. McNamara has made it clear that NMCS should *not* be a one-shot system, but a long-term adaptable one.

Subs for Surveyor Orbiter . . .

NASA Seeks New Lunar Photo Craft

Use of Atlas-Agena instead of lagging Centaur vehicle should cut by one-third cost of LEM landing area study

by Hal Taylor

NASA HAS ASKED industry to submit bids by Oct. 4 on a lunar orbiter photographic spacecraft project estimated to cost $75 million.

The program calls for five flight and three ground-test models to be built for missions beginning in 1966. The 800-lb. spacecraft will be launched by the *Atlas-Agena* booster from Cape Canaveral.

Capt. Lee Scherer, director of the space agency program, said each of the five flights will cost $14 to $16 million, about the same price as the *Ranger* lunar hardlanding spacecraft.

Personnel, ground support, launch vehicle and spacecraft costs should bring the total pricetag to $70 to $75 million, Scherer told MISSILES AND ROCKETS.

Scherer said additional spacecraft may be added to the program later, especially if there is slippage in the *Apollo* lunar landing program.

He also said that since the *Apollo* spacecraft will be in an equatorial orbit around the Moon, it is not unreasonable to put the new spacecraft in a polar orbit to take pictures of other areas of the Moon not covered by *Apollo*.

Its prime objective is to gather data on the lunar surface so that landing sites can be selected for *Apollo* manned lunar landing missions.

- **Undercuts Surveyor**—The as yet unnamed spacecraft replaces the *Surveyor Orbiter* program, for which NASA is authorized $20 million in its Fiscal '64 budget.

Scherer said the switch from the heavier *Surveyor Orbiter*—to be launched by *Centaur*—was made because the *Atlas-Agena* is cheaper than the *Centaur*. He predicted that the new program will be only two-thirds as expensive as the *Surveyor* project.

He added that the *Surveyor Orbiter* and the *Surveyor* softlander were both scheduled for launch in the same period, putting them in competition with each other. "We feel we will be able to do the job with the smaller spacecraft," he said.

Not cited by Scherer, but still a definite reason for the switch to the new program is the long delay in development of the *Centaur* vehicle. Space agency officials are convinced that there won't be enough *Centaurs* ready for flight in 1966 to launch *Surveyors* on both soft landing and lunar orbiting missions.

Conversely, Scherer said that the current *Ranger* lunar hardlanding spacecraft could not be used for the new project because the orbital mission would require changes in its guidance and control mechanism. He added that *Ranger's* retro-rocket system is too small to brake the spacecraft into orbit and that it is not thermally designed for an orbiting type mission.

In requesting proposals, the space agency said that only firms with prime contract management capability should bid. Officials said that they expected firms to bid as teams because of the complex photographic equipment required.

The request for proposals was issued by NASA's Langley Research Center. The project will be under overall direction of the Office of Space Sciences, with Langley responsible for project management.

- **Requirements**—The space agency said the spacecraft should be capable of obtaining its pictures from an altitude of not closer than 22 mi. above the surface of the Moon. From that range, a camera system capable of making high-resolution photographs of the lunar surface will gather the information required. At somewhat higher altitudes, the system will make medium-resolution pictures.

According to present plans, medium-resolution photographs are needed to make an initial screening of the lunar surface to avoid landing *Surveyor* softlanders in areas clearly unsuitable for landing the *Apollo* Lunar Excursion Module. A segment of the lunar surface about 15,000 sq. mi. in extent is to be covered by the medium-resolution pictures.

High-resolution pictures will be taken over potential LEM landing areas where *Surveyors* have been landed to make detailed topographic and surface material studies. As a design target, NASA is asking for a high-resolution camera capable of detecting lunar features about the size of a small sports car. It will be required to identify nearly flat areas 25 ft. square—the area needed for a LEM landing.

Detailed camera requirements include:

Region of Coverage—Anywhere within ±10° latitude and ±60° longitude, as selected by NASA for each mission.

High-Resolution Mode—

—Total coverage per mission—at least 2,000 km^2.

—Single area contiguous coverage—minimum dimension to be 12 km., larger is desired.

—Ground Resolution—one m. per optical line pair at a marginal overall signal-to-noise ratio. This should permit detection of right circular cones ½ m. high and over 2 m. in base diameter (under optimal lighting conditions and with the assumed lunar photometric function). Ground slopes of 7 degrees over a 7 x 7 m. area should be detectable in favored directions with respect to the Sun's azimuth. Detection can be accomplished by albedo variance, shadows or stereo.

Wide-Coverage Mode—

—Total coverage not specified, but should be as large as possible.

—Single area contiguous coverage—at least 40,000 km^2, with minimum dimension at least 100 km. ■

An M/R exclusive . . .

'Hardened' Electronic Systems Urged

Nuclear radiation damage countermeasures advocated for use in space

by John R. Crittenden

General Electric Company

NUCLEAR RADIATION does damage electronic equipment. The evidence is quite conclusive.

While the exact point of failure may not be well-defined, the many tests performed by both industrial and government laboratories during the past few years all show that radiation will change the characteristics of electronic devices and materials. In some instances, only a brief exposure is enough to cause total failure, while other systems are considerably more tolerant.

In many respects, nuclear radiation is similar to temperature extremes—once the range is known and the capabilities of electronics to operate over that range are defined, it is relatively simple to include temperature effects as a design consideration, a parameter in the mission objective planning.

Unfortunately, many mission planners and designers do not yet recognize the limitations imposed by nuclear radiation effects on electronic systems.

Data describing the behavior of electronics when exposed to radiation are difficult to interpret and apply. The task of educating designers and planners to understand and anticipate radiation effects is enormous. Many designers may be familiar with the well-publicized aspects of nuclear radiation, but too often they do not comprehend the insidious secondary effects, nor do they understand the seriousness of the transient effects that can be produced by a short pulse of radiation.

- **Degrading effects**—Accompanying the well-publicized effects of radiation, such as the deterioration of semiconductors, are increased leakage currents that distort or change circuit operation and gas evolution. Over a long period of low-level radiation, the gasses released may corrode exposed metal surfaces or cause a sealed container to explode.

Organic materials widely used in electronic equipment such as potting compounds and insulation often become brittle or swell. Printed circuits may be displaced or broken. Even more serious is the continuing deterioriation which follows exposure. Actual component or subsystem failure may not occur until weeks later.

Transient effects do not cause permanent damage to electronic parts, but they may be the cause of system malfunction. Such effects are similar to the momentary blindness following the flash of a nearby photoflash lamp. If the blindness occurs at a critical moment, perhaps while driving, the result may be fatal. An electronic circuit responds to a radiation pulse in the same way. Its circuits are momentarily saturated. Thus, a missile might lose the target, or a radar could fail to detect an aggressor projectile.

- **Head-in-sand planning**—In the past, normal procedure has been to delay the development of electronics hardware until the powerplant and vehicle were proven. In some recent cases where this procedure was followed, the weapons system became obsolete before the electronic gear was completely developed.

Much more serious, however, is the frequent practice of planning a mission or weapon system on the assumption that the electronics can be bought "off-the-shelf" and made to work.

The electronic-system designer for a space mission faces a major problem which limits the total mission capability. The space enviroment is antagonistic to electronic devices and materials. Near Earth, trapped particles irradiate satellites and cause their components to fail.

Also, some future satellites or launch vehicles may use nuclear energy. The radiation which accompanies the release of nuclear energy can similarly create damage to electronic equipment.

The military electronic-system designer has an additional problem to solve. His equipment must tolerate an attack; it must perform before, *during*, and after without change. The aggressor may choose a nuclear weapon. The

GE-Owensboro Attack Vexing Radiation Problems

GENERAL ELECTRIC'S Receiving Tube Department in Owensboro, Ky., for several years has pressed research into the problems of radiation effects of high-intensity pulses on electronic components.

Paralleling this effort, the division continued development and testing of its proprietary ceramic electron tubes and TIMM's (Thermionic Integrated Micro Modules).

On July 30, 1963, the *St. Louis Globe-Democrat* published a front-page story describing the crippling by pulse radiation of an unnamed U.S. satellite by Soviet high-altitude nuclear tests during late 1962.

Six days later, on Aug. 5, GE-Owensboro ran a full-page advertisement in the *Washington Post* that reproduced the *Globe-Democrat* story and asserted that "now electronic systems can be 'hardened' against crippling nuclear radiation with TIMM circuits."

Shortly thereafter MISSILES AND ROCKETS learned that copies of the ad and additional data to support its case were sent by GE to Kentucky's U.S. senators and representatives and to space committeemen of both houses. The letter was signed by J. R. Topper, GE-Owensboro's product sales planning manager.

In summary, GE pointed out that a one-megaton nuclear explosion in space produces a 10^7 R/sec. pulse that can be harmful to electronic systems over a radius of 110 miles or more. TIMM circuits, GE disclosed, are capable of withstanding 10^9 R/sec. pulses and 10^{19} nvt fast neutron exposure without shielding. Thus, the division claimed, TIMM circuits would function without degradation 97 miles closer to such a blast than conventional electronic circuits.

The article above was prepared at M/R's request by Mr. Crittenden, who directed GE's radiation studies at Owensboro. He is now a radiation-effects consultant for GE at Redstone Arsenal, Huntsville, Ala.

detonation of these weapons produces damaging radiation over the entire electromagnetic spectrum.

The prompt gamma pulse will affect electronic devices sensitive to ionization, and the radio-frequency signal propagated carries enough energy to damage electronic circuits drastically. Experiments have shown these products of a nuclear event are effective far beyond the normal range of an explosion.

- **Design for tolerance**—The electronic systems now in use and being developed for future space applications have demonstrated their capability to meet today's needs. Since the requirements for future systems have not been thoroughly defined, it is reasonable to question whether today's electronics can be improved to the extent necessary to carry out long-term space missions, deep-space probes, or military missions.

Very few manned missions are totally dependent on the satisfactory performance of electronic equipment. Failures may be inconvenient, but they are not normally fatal to the humans nor do they abort the mission.

Unmanned space missions are completely dependent on the operation of complex electronic gear. Malfunctions are difficult, if not impossible, to correct. Repairs are impractical. Failure invariably aborts part or all of the mission.

The system designer has the unenviable task of reaching the optimum compromise between component capabilities and the mission of objectives, which were defined without regard to the limitations inherent in electronic equipment. In the future, this approach may prove exorbitantly expensive.

A bridge builder constructs his bridge to sustain two or three times the maximum conceivable load the bridge may ever bear. Sometimes the safety factor is as great as ten. An airplane designer is somewhat limited by weight restrictions, but he still studies the maximum expected loads and applies a safety factor. Neither would consider using an untested marginal material.

Electronics for use in space should have the same consideration. Materials and devices known to be sensitive or failure-prone should not be used. Every effort should be expended to provide an electronics system with a safety factor which will not compromise the mission.

Test data clearly show that today's electronic equipment is vulnerable to nuclear radiation. Rather than burden system designers with the problem of interpreting and applying radiation effects data, considerable time and money could be saved by developing a "hard" electronic system—an electronic system with a built-in safety factor. ■

After changes at Lewis . . .

Centaur Flight in Fall Will Be Stringent Test

by Chris Butler

CAPE CANAVERAL—The toughest test yet devised for an unflown space vehicle has been programmed for the *Atlas-Centaur* scheduled to be launched in mid-November or later.

The entire *Centaur* stage will be placed in an elliptical orbit, ranging between 300 and 800 mi. above the Earth's surface, to prove the validity of the *Centaur* concept and the performance of its Pratt & Whitney RL-10 liquid hydrogen engines.

Primary objectives of this particular mission are to test the structural integrity of *Centaur,* to demonstrate stage separation, ignition and operation of the engines, and to evaluate the *Centaur* guidance system.

General Dynamics/Astronautics and NASA spokesmen say the *Centaur* soon to be checked out here differs little from the first *Centaur,* which was destroyed by fire shortly after launching on May 8, 1962.

Problems of varying magnitude plagued the *Centaur* test program during the ensuing months. One *Centaur* stage was destroyed when an *Atlas* exploded on a nearby test stand.

The delays finally sparked a Congressional inquiry into the lagging program. Many now working with *Centaur* feel the inquiry prompted NASA to assign the DX super priority to the program.

During the 15 months since the first launch, huge amounts of ground-test data have been used to verify the *Centaur* design and study performance of the engines and other components.

As the program moved into "high gear," NASA headquarters reassigned overall project responsibility from Marshall Space Flight Center to Lewis Research Center. Launch responsibility was assigned to Goddard Space Flight Center's Field Projects Branch at the Cape.

- **Changes made**—Lewis engineers immediately began studying the *Centaur* vehicle and launch procedures and ordered several changes.

One of the most significant is the use of a liquid helium purge at —460°F to chill down the second-stage engines before launch. The engine temperature is expected to be at about —200°F at separation.

This pre-chilled condition is expected to cut coast time from 40 to about 6 sec., and correspondingly reduce the amount of liquid hydrogen needed to lower engine temperature to levels required for ignition.

Centaur efficiency will be increased through reduction in weight of liquid hydrogen needed. The short coast period also will eliminate most of the need for ullage rockets to position propellants in tanks after a long coast.

NASA spokesmen say liquid helium was chosen because its extremely low temperature and inert properties eliminate any chance of combustion when second-stage engines are ignited.

- **Flight plan**—The *Atlas-Centaur* is scheduled to be launched on a 105-deg. azimuth from Complex 36A. After first-stage burnout, a shaped charge will be exploded to cut the metal interstage adapter. The shaped charge is an innovation that replaces pneumatic latches to effect separation.

Four 50-lb. ullage rockets will propel *Centaur* away from first stage while eight solid retro rockets, located near the *Atlas* skirt to prevent blast damage, will slow the main stage and widen separation before ignition of the RL-10's.

The *Centaur* stage will carry a full load of propellants. The tanks will contain 4,620 lbs. of liquid hydrogen and 23,000 lbs. of liquid oxygen.

Centaur is scheduled to burn 380 sec. and the entire stage will be injected into orbit about 400 mi. north of Antigua.

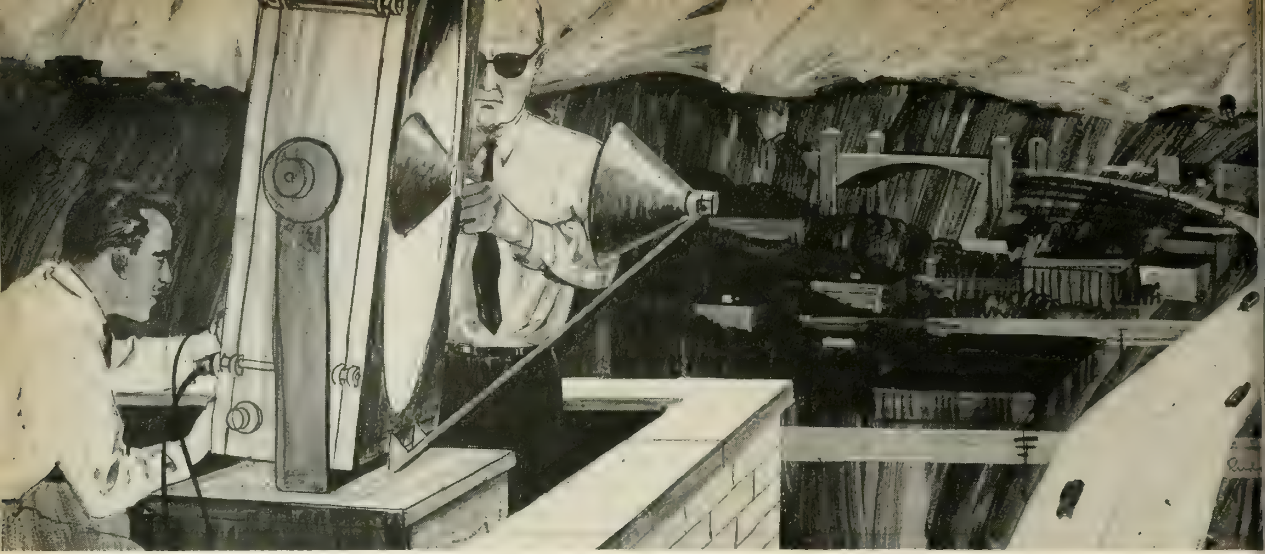
Going into orbit with the stage will be an external insulation jacket used to protect the cryogenic propellants.

Upper-stage insulation panels, which were scheduled to be jettisoned during flight, broke loose 55 seconds after launch and aborted the first *Atlas-Centaur* test.

Present plans call for follow-on *Centaur* vehicles to have light, jettisonable insulation panels, but Lewis engineers are experimenting with a lightweight panel that can be retained as part of the vehicle.

The *Centaur* guidance package developed by Minneapolis-Honeywell is scheduled to fly open-loop on the upcoming flight, which will be controlled by an autopilot.

Present plans call for launch of a third *Centaur* about eight weeks after the November flight. ■



1933 target: vehicles on a highway

1963 target: vehicles in space

Thirty years ago, Westinghouse engineers in East Pittsburgh beamed radio waves from the plant roof and detected moving autos a block away. They didn't call it "radar"—the word hadn't been invented yet.

Radar development at Westinghouse has traveled many paths since 1933. Defense Center scientists have consistently pioneered in advancing the art—from the rooftop experiments to detecting enemy planes approaching Pearl Harbor to tracking vehicles in space.

Systems in action today include radars for airborne and space missions, search and weapon control, tactical and fixed air defense, shipborne and ground-based acquisition and tracking. Typical of current projects of the Westinghouse Defense Center are the AN/SPG-59 shipboard fire control radar for the Navy's TYPHON program and the land-based AN/FPS-27, a long-range air defense radar in the Air Force's SAGE system.

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Technical Countdown

ADVANCED MATERIALS

Beryllium-Aluminum Alloy Licensed

Lockheed Missiles and Space Co. has granted an exclusive license to Dow Chemical Co. to produce and market the Lockheed-developed beryllium-aluminum alloy family known as Lockalloys. The alloys are significantly less costly than beryllium and are relatively easy to fabricate. There is a significant weight reduction available in using the alloys on upper stage vehicles—up to 35% over present materials. The alloys contain as much as 85% beryllium. Dow spokesmen are optimistic about large-volume production in the near future. A substantial market was predicted by both firms. No physical or chemical data on the new alloys was disclosed except that the Young's Modulus of Lockalloy sheet at room temperature is 28 to 33 x 10^6; Lockalloy extrusions, 33 to 36 x 10^6. At 800° F the values are 25 to 29 x 10^6 and 26 x 10^6, respectively.

Li-Cooled Reactor Experiment Cancelled

A lithium-cooled reactor experiment designed to supply certain data to the *SNAP 50* program has been cancelled by the AEC after a review disclosed the project would not make a significant contribution to the overall program. The cancellation will cause some personnel reduction at the AEC's Connecticut Advanced Nuclear Engineering Lab operated by Pratt & Whitney Aircraft division of United Aircraft Corp. Modifications to structures at the National Reactor Test Site in Idaho will be halted. P&W is under contract for work on certain components for the first prototype *SNAP 50*. This work will continue. The *SNAP 50* program has been essentially re-oriented toward the prototype construction.

Noise Lab Nears Completion

Air Force Systems Command's Research and Technology Div. is nearing completion of a sonic fatigue facility at Wright-Patterson AFB. The facility is designed to subject test specimens to a 160-db re 0.0002 microbar S.P.L. random incident sound field in a 70 x 56 x 42-ft. reverberation chamber. Twenty-five variable-frequency sirens provide sound in the 50 to 10,000 cps range.

Spike-Tip Re-entry Considered

Substitution of a long, spike-like projection on re-entry bodies instead of the more familiar blunt configuration is under consideration at the hypersonic research branch of the Aerospace Research Labs at Wright-Patterson AFB. The spike would divert gases to each side of a re-entering body. AF researchers expect the deflected gases to have lower temperatures than that facing the blunt heat shield and the positioning of the spike off-center has the effect of providing some lifting force to the vehicle. While current work is highly theoretical, the indications are that the spike need not be solid—that a projected gas stream would also serve.

Radiation Effects Tabulated

Scientists at Battelle Memorial Institute will be subjecting various electronic components to radiation in vacuum conditions under a contract from NASA's Jet Propulsion Lab. The Radiation Effects Information Center at Battelle will store the data for easy access. The components will be mounted in specially designed arrays and subjected to neutron and gamma bombardment, high vacuum and elevated temperatures. All parts will be energized for 10,000 hours. Other materials under test include metals, alloys, propellants, fuels, lubricants and some explosives.

Avco Moves Into Metallizing

The Industrial Products Subdivision of Avco Corp. is expanding its plasma coating product line to include a complete array of oxyacetylene wire feed guns and accessory equipment. The move is the first step in a planned program to expand Avco's services in composite materials. The metallizing equipment is complementary to the Avco plasma line since the superiority of the plasma-applied coating cannot, in many cases, justify the large investment necessary for the equipment.

Boron Structures Filament Wound

The Materials Laboratory at Wright-Patterson AFB has succeeded in drawing boron filaments to the extent of winding small laboratory model structures for test purposes. NOL rings have been made. Boron filaments greatly exceed glass in tensile strength per unit of weight. The major problem has been to draw filaments of the proper diameter in sufficient lengths to apply to structures.

ELECTRONICS

Low Loss Millimeter Waveguide Designed

A new waveguide for the low loss transmission of millimeter waves has been designed by F. J. Tischer of the University of Alabama Research Institute in Huntsville. The guide consists of two parallel conducting walls with grooves in the central region of the guide cross-section. The grooves run along the guide in the direction of wave propagation. At millimeter frequencies, engineers report that the attenuation of rectangular waveguides is intolerably high. The groove-guide, when excited by TE-type waves, is expected to have considerably lower losses. Other advantages cited include high power handling capability and very small currents on the walls in the direction of wave propagation. The latter permits the addition of sections without connectors or flanges.

Lasers Check Optical Instrument

Engineers at Perkin-Elmer Corp., Norwalk, Conn., are using gas-phase lasers coupled with a Twyman-Green type interferometer in production checks of large optical lenses and prisms. P-E reports observing fringe patterns indicative of optical homogeneity in paths as long as 14-in. large prisms. Earlier use of mercury arc lamps for this generally limited inspection to glass thicknesses no greater than about one inch.

PROPULSION

Big Solid Facility Construction Contract Awarded

Thiokol Chemical Corp. signed a construction contract with the Daniel Construction Co. for nine buildings at the propulsion firm's Camden, Ga., large solid facility. The $988,000 contract calls for the completion of two full scale mixer buildings, a mixer control building, an inert parts preparation facility, a mixer surge building, a mixer utility building, an oven building and a ballistic test motor preparation site by mid-February, 1964. An inert parts facility is already completed and work is progressing on the giant casting, curing and testing pit plus a network of roads, electrical and water systems.

Pioneer Program Decisions Expected in Next Few Weeks

Payload, launch vehicle, tracking station requirements to be detailed; magnetic 'cleanliness' is major design problem; six experiments planned

by Michael Getler

MOFFETT FIELD, CALIF.—Key decisions concerning the scientific payload, launch vehicle, and tracking station requirements for NASA's newly initiated *Pioneer* satellite program will be made within the next few weeks.

The *Pioneer* project, managed by Charles F. Hall of the Ames Research Center here, is part of NASA's lunar-interplanetary program and is expected to yield considerable inputs to the manned lunar landing effort and other interplanetary probes during the "Quiet Sun" year, an 18-month period during 1964 and 1965.

Current plans call for an early 1965 launching. Space Technology Laboratories, Redondo Beach, Calif., a subsidiary of Thompson Ramo Wooldridge, Inc., will design and build four of the satellites for NASA under terms of a $15-million contract awarded in June.

Pioneer, though undoubtedly one of the simplest of the space agency's scientific probes, will also be one of its most unique. If pre-planned, sequential launch schedules are met, two of the vehicles at widely separated points in space will be able to yield time-coordinated measurements providing comparative data on direction of solar activity, field and partical strengths, and a wide variety of other interplanetary phenomena.

- **Magnetism considerations**—The satellite will also be the most magnetically "clean" spacecraft known to have been sent aloft, and could influence design in this regard for other type vehicles. *Pioneer* will carry an extremely sensitive magnetometer within its payload. This has imposed a low-magnetic-field design requirement for all on-board systems that challenges conventional spacecraft design.

Additionally, NASA points out, *Pioneer* will need no on-board guidance system in the traditional sense. The object is not to arrive at any particular point in space, "but just to get out there."

The four vehicles planned are divided into two sets. The first launching will be toward the Sun, to within 0.95-0.80 astronomical unit (AU). The second shot will follow in four months and will be fired away from the Sun to within about 1.2 AU.

New Instrument Is Heart of Ames Momentum Test

MOFFETT FIELD, CALIF.—The Ames micrometeoroid momentum measurement experiment is based on a new instrument NASA scientists believe represents orders of magnitude improvement in the state of the art for measurement of force and impact momentum. The package, developed here by research scientist, Vernon L. Rogallo, will reportedly measure forces on the order of a microgram or momentum on the order of 10^{-5} dyne seconds.

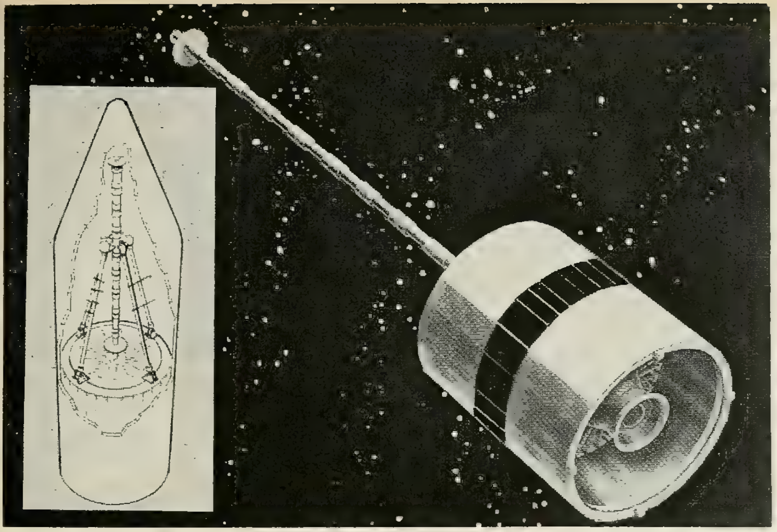
Though designed for the micrometeoroid detector, the device should have applications in a host of other fields including guidance systems, laser energy measurement, and biomedical research.

The measurements research branch at Ames has been using the device to measure momentum accommodation on various surfaces associated with a pulsed laser. Aim of the study, NASA reports, is to investigate some aspects of cratering phenomena in solid materials using focused and pulsed laser light to compare results with what is known about ordinary hypervelocity impacts. The physics branch at Ames is also using this device to measure momentum accommodation associated with ion beam impingment on a metal surface.

Though details of the Rogallo design have not yet been released, MISSILES AND ROCKETS has learned that the device is basically a spring-mass system that acts as a single-degree-of-freedom unit. The mass, or target area, can have a surface of 1,000 cm, according to Rogallo, with an associated weight of about 60 grams, and still give the 10^{-5} dyne sec. sensitivity.

Mechanical noise has set the limit at this level. The spring in the system is of an unconventional design and is actually a piezoelectric sensor (there is more than one P-E element), with the displacement giving the output. The system reportedly can measure a displacement of 2 angstroms.

Additionally, Rogallo says the device can handle several target



PIONEER SOLAR PROBE deployed in space. Inset shows satellite inside final stage.

- **Satellite shape**—*Pioneer* will be cylindrically shaped, 32 in. long and 37 in. wide. The spacecraft shell will be of thin (20 mil) honeycomb aluminum. The entire surface, with the exception of a 5-in.-wide band around the satellite mid-section, will be covered with solar cells. P-N type cells were originally chosen, but design may shift to N-P type for radiation resistance advantages and possible improved operating efficiency.

The 5-in. band around the satellite will allow measurement of the space environment by the experimental packages on-board. The payload and all other equipment will be carried on a single plate within *Pioneer*, with the bottom of the plate corresponding to the bottom of the 5-in. strip. This provides ease of maintenance. Access to the systems is from the top of the satellite. Internal temperature will be controlled by a series of louvres to 60°F ±30°.

The satellite command system will probably combine portions of the *Ranger-Mariner* system, using frequency-shift modulation for the up-link and phase-shift on the down-link.

About 64 discrete commands have been programmed for *Pioneer* to date. The system will use PCM telemetry, though the number of carriers (either 1 or 2) is not firm. This will be tied to the space agency's Deep Space Instrumentation Facilities (DSIF). Bit rates are expected to vary between two and 500 bits per sec., depending on altitude.

- **Traffic problem**—Since *Pioneer* is apt to be in space at the time the *Mariner* Mars probe is also aloft, officials here say there will be an attempt made to keep the *Pioneer* in an opposite direction from *Mariner* to avoid DSIF allocation problems. Three DSIF antennas probably will be required.

Another unique feature about *Pioneer* is that this is the first time the Jet Propulsion Laboratory-managed DSIF will be supporting a space probe program it has neither developed nor managed.

Total power generated aboard *Pioneer* is expected to be about 60 watts at maximum distances, with 120 watts possible at closest approach when fired toward the Sun.

Pioneer will also carry a small battery to provide power during initial solar-cell orientation of the vehicle shortly after launching. It will then be disconnected.

Pioneer will carry a single on-board transmit-receive antenna extended on a boom about 50 in. from one end of the vehicle. The unit is a high-gain, narrow-beam 18-element Franklin array, which gives a fan-type wave pattern with the elements excited in phase. Gain of this unit is reportedly 13 db and beamwidth about 10 degrees. There is also a small, low-gain, wide-beam isotropic antenna mounted on top of the array extension that will be used for initial orientation.

- **Stabilization**—*Pioneer* will be spin-stabilized at about 90 rpm and will use a two-phase reorientation control system to carry out the required attitude-control functions of the vehicle. The system includes solar sensors and a cold-gas (nitrogen) jet with a nozzle mounted on top of the antennas.

After launching, the automatic mode becomes operational, with the spacecraft using the solar sensor inputs to align itself so that the spin axis of the vehicle is perpendicular to the probe Sun-line.

With this orientation bringing up full solar cell power, the low-gain antenna begins to operate and the satellite is then oriented via ground command so that the spin axis is perpendicular to the plane of the ecliptic, pointing the high-gain antenna at the Earth.

Pioneer also includes considerable redundancy—traveling wave tubes for transmission power, decoders, receivers and diplexers are all duplicated.

Pioneer will weigh about 120 lbs., but its launch trajectory and payload are still somewhat unsettled because of possible booster changes. A three-stage vehicle will be used for the launchings from Cape Canaveral, but engine configuration has not been chosen.

- **Booster**—The two-stage *Thor-Delta* vehicle is being considered in combination with the Allegany Ballistics Laboratory X-258 as a third stage. Also, a *Thrust-Augmented Thor* (TAT) with the *Delta* and either the X-258, or the earlier X-248 is possible.

The X-258 is preferred over the X-248 because its smoother burning offers less vibration. The X-258, however, has not yet been flight tested with the *Thor*. A test may be made this fall.

The mission could be accomplished in varying degrees of effectiveness with each of the combinations, but the TAT-Delta-258 combination would reportedly provide the full scientific payload capability, and allow an optimum trajectory, easing launch-time problems.

Using the X-258 without TAT, say NASA engineers, means that the second stage will not go into orbit and must be jettisoned so that it lands in the Atlantic Ocean just west of Africa

(continued on page 43)

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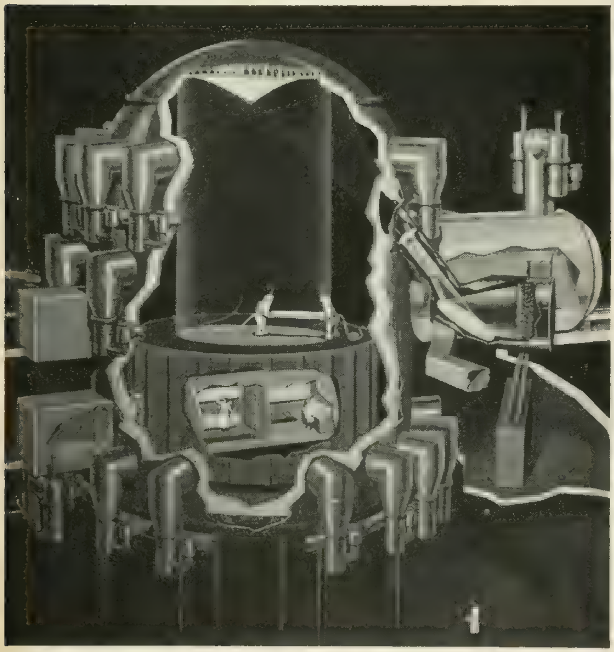
shapes, can be operated with equal sensitivity in any attitude, and can operate in a steady-G field. He also points out that sensitivity is the same no matter where on the mass the impact is made, and that the device is also directionally sensitive.

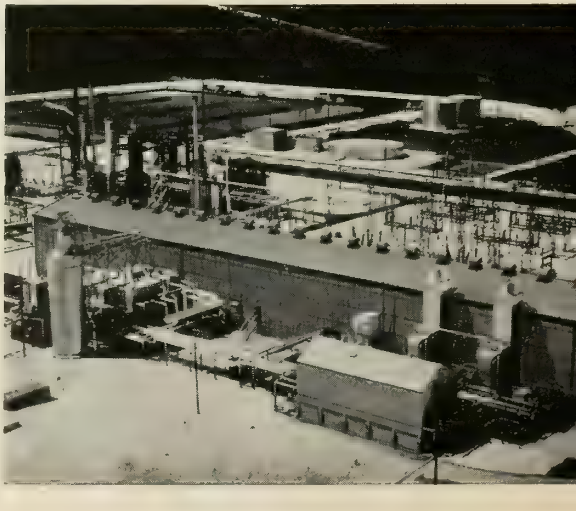
Design is said to be complete on a system that adds other elements to give a directional readout. The entire system, including the target, weighs about 200 grams, and requires about 150 milliwatts for system power.

As an example of instrument measurement capabilities, Rogallo says the device will measure one thousandth of the impact produced by dropping a grain of table salt ⅜ of an inch.

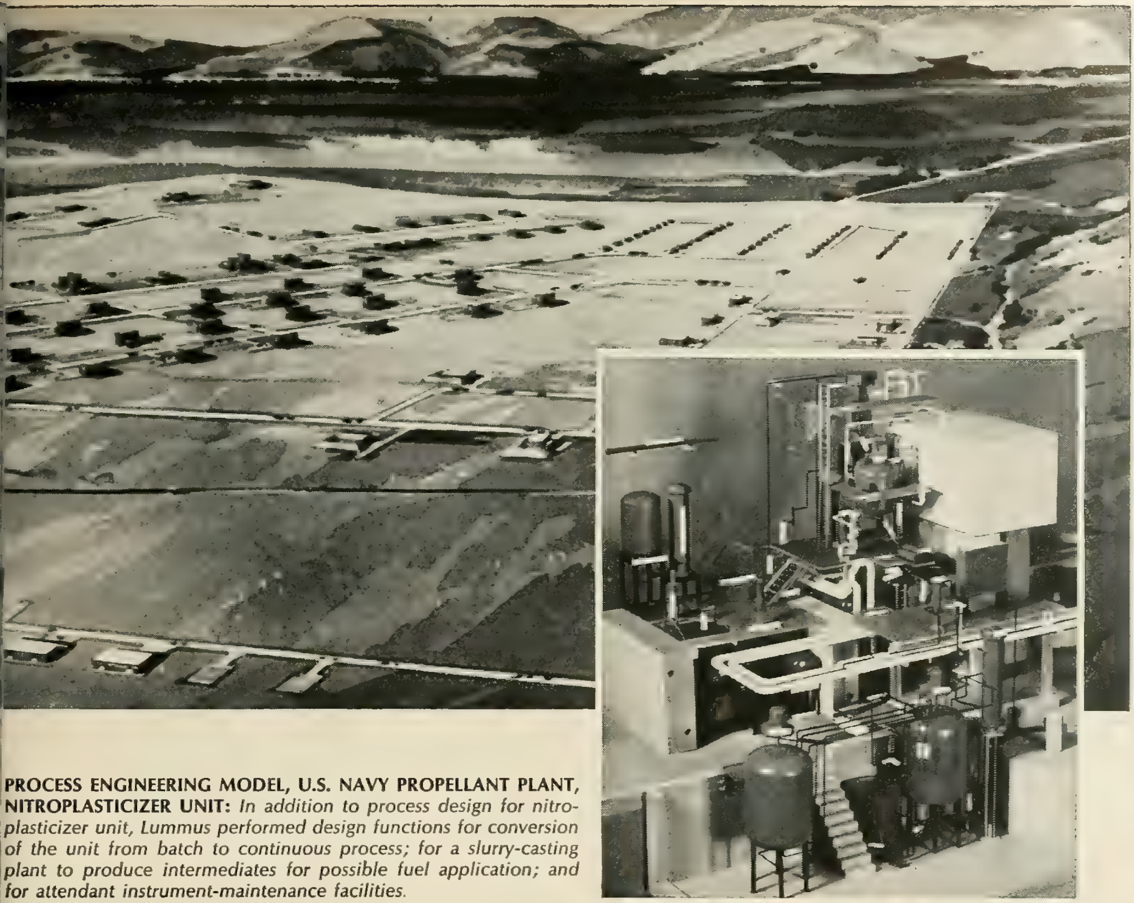
SOLID PROPELLANT PRODUCTION FACILITY—U.S. AIR FORCE PLANT #78: *Lummus' architect/engineering design for this propellant complex included auxiliary facilities for MINUTEMAN horizontal engine testing, propellant handling and storage considerations, and rocket-engine handling.*



LUNAR ENVIRONMENTAL RESEARCH FACILITY—U.S. ARMY CORPS OF ENGINEERS: *Lummus performed the conceptual engineering for this simulator which established the engineering feasibility to provide for vacuums up to 1×10^{-8} torr, temperatures as low as −423°F, and solar radiation twice the intensity of the noonday sun—up to 130 watts/sq. ft.*



WORLD'S LARGEST LIQUID HYDROGEN PRODUCTION FACILITY—U.S. AIR FORCE PLANT #74: *Lummus designed, engineered, and constructed the hydrogen-production process phases of this plant to produce 99+% pure hydrogen, which is then liquefied through cryogenic processes.*



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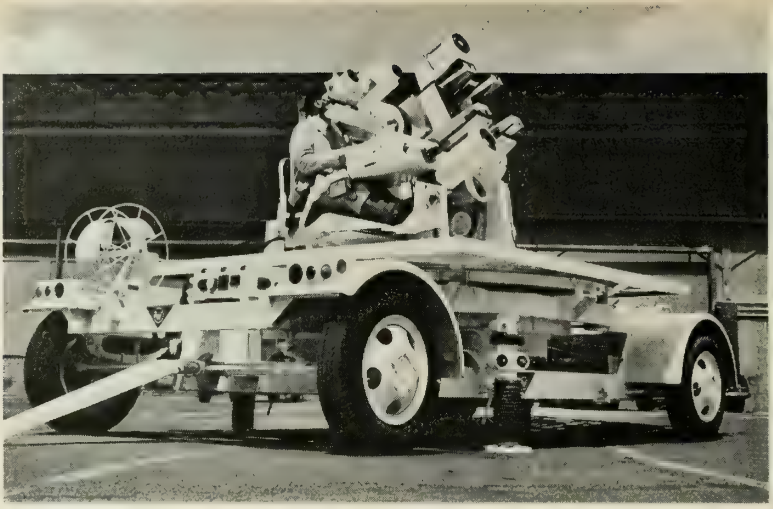

OPERATOR astride MOPTS peers through sighting scope.

AMF Tracking Mount on Job at PMR

by William Beller

A MOBILE photographic tracking station (MOPTS), which slews fast enough to track a rocket sled accurately or slow enough to follow an Earth satellite, recently went operational at the Pacific Missile Range (PMR), Pt. Mugu, Calif.

The versatile mount is built to run four cameras and accommodate 16-mm, 35-mm and 70-mm units as well as larger ones.

One advantage of MOPTS lies in the precision of its elevation and azimuth movements, maintained within eight seconds of orthogonality. This is one of the factors leading to PMR's choosing the mount as part of its range equipment. Most mounts in use are accurate only within 60 seconds.

Developed by the Advanced Products Group of American Machine & Foundry Co., MOPTS is used on the Pt. Mugu range to track missiles during the launch phase and also very fast-moving aircraft.

At the present time, no position data are obtained: only the image of the photographed body is shown on the film.

When MOPTS becomes a cinetheodolite, angular tracking data will appear either on the film in digital code or on a separate digital tape timed to the film strip.

Another MOPTS advantage lies in its "stiff stick" control. Instrument mounts are usually operated manually either by a big hand-wheel or by a "joy-stick" similar to the control stick in aircraft. The "stiff stick" lends two important benefits: less physical effort is required by the operator, and the normal overshoot attending control operations is eliminated.

- **Highway traveler**—MOPTS is installed on a four-wheeled trailer able to travel up to 55 mph on first-class roads. When the mount is implaced, it can be precisely leveled by means of three jacks.

The operator rides on the azimuth platform. His seat can be tilted from −5° to 50° about the elevation axis to increase his tracking efficiency. The camera and lens mounting brackets are the same as those on the conventional M-45 mount to permit ready interchange of equipment.

Overall mount dimensions: 9 ft. 8 in. wide, 19 ft. long, 12 ft. high. The mount has a one-ft. road clearance and is designed with leaf springs and shock absorbers on each wheel.

- **Stiff-stick control**—There are two basic modes of control: a manual mode; and a completely automatic mode using a positional servo system, which can be linked to the range radar system.

In the manual mode, the operator—assisted by prediction circuitry—is able to apply corrective action proportional to the observed position and velocity errors. Observing the target through a sighting scope, he orients the mount with a two-axis stiff-stick controller.

When the operator pushes the stick horizontally, he activates linear variable differential transformers which provide signals proportional to the force exerted and its direction. A backward or forward force will bring a mount motion about the elevation axis, while a sideward motion will cause movement in azimuth.

- **Servo control**—AMF claims that MOPTS has a stepless speed range ratio of 14,000:1, and a minimum smooth speed of one revolution per day.

The problem of achieving smooth low speeds in mount-driven systems is directly related to the torque disturbances imposed on the system. These disturbances are introduced by fluctuating wind loads, variations in bearing friction, and cogging characteristics of drive motors. Reduction of these disturbances is necessary to attain smooth mount operation at or below the speed of the Earth's rotation. AMF does this by using an astrodome enclosure to eliminate much of the wind loads, and by high-quality bearings.

The remaining torque disturbances are counteracted by a high-performance, servo-controlled mount drive system. The degree to which the MOPTS servo system offsets the influence of perturbing forces and permits smooth operation at low speeds is attributed to two factors: the high quality of the low-noise feedback element, and the high gain of the servo loops.

- **In the future**—AMF anticipates that further refinements can be added. TV remote operator control has been investigated for installation in the mount design, and it's possible that in the future a completely automatic TV control system will be added.

Provisions have been made for installation of integrally mounted shaft-angle encoders, to provide time-correlated records on magnetic tape suitable for direct entry into a fully automated data processing and reduction system. ■

Laser Optics Encountering Deterioration Problems

High-energy light damages lenses, mirrors—even rubies; laser photography is not yet producing desired results

by Rex Pay

LOS ANGELES—Increasing laser powers will be accompanied by more frequent lens and mirror damage, predicts W. C. Davis, senior research engineer at North American Aviation's Autonetics Div.

Laser optical system damage was among topics discussed here during the 8th Annual Technical Symposium of the Society of Photographic Instrumentation Engineers, along with problems being encountered in the promising area of laser photography.

Although damage to such laser elements is a recognized problem, improvements in component resistance to damage have been made during the past year. Thus, many experts feel that this problem will be overcome soon.

Discussing laser damage with Davis and others working in this field, MISSILES AND ROCKETS learned there are three general problem areas.

Damage to rubies—Ruby laser crystals are themselves damaged. Looking rather like the result of etching, the damage has sometimes been blamed on voltage breakdown across the ruby. But, say the experts, this seems unlikely. The laser beam itself seems to be the culprit: similar damage has been produced by focusing a laser beam on to a ruby.

One current idea is that 90-degree rubies are more likely to suffer this type of damage than are 60-degree rubies.

Rubies of better optical quality might be more resistant to damage. Certainly, better rubies are needed to narrow laser beam angles. Present beam angles are about 0.01 radian. With rubies of better optical quality, beam angles of 0.00001 radian could be achieved.

Metal films go first—Metal films on the mirrors are the first components in a laser system to go. Pin-holes start to develop, or the film disappears.

Multi-layer dielectric films are being developed that are more resistant to laser damage. Yet, failure mechanisms in such films are not yet fully understood. An experimental film of this type might operate without apparent damage for 20 laser firings and then disappear on the 21st firing. Much longer lifetimes than this have been achieved, however.

One way of avoiding use of mirrors is to use prisms. An alternative technique to using ruby-laser end mirrors involves splitting the rod in two and inserting a Kerr cell in the center. The reflecting powers of the ruby end-faces are then sufficient to maintain laser action.

Doublets are out—Lenses with high curvature are also quickly damaged. Internal focusing of the laser beam within the lens causes fractures and voids. A doublet lens is typically fractured along its joining plane and will fly apart if not clamped.

A refracting telescope in a laser range finder suffered severe damage in the eyepiece when a laser beam went through it.

"Combination lenses are absolutely useless in high power laser systems," said Davis.

Kerr cells in Q-spoilers also have shown degradation due to the passage of laser radiation. Damage appears as striations in the field direction.

Transparent plastic materials show some of the most severe damage. Carbonization takes place inside the material, producing opaque black areas in the path of the light beam.

The main ways available to overcome these damage problems are to spread out the laser beam when optical processing takes place and to use materials with extremely high dielectric strengths.

- **Effects in transparent blocks**—Davis focused the beam from a 50-kw 0.3-joule laser into a number of different transparent materials. At this power the laser was operated in a pulse-train mode. By use of a Q-spoiler, it was also operated in a giant-pulse mode with a power output of 1 to 5 megawatts and somewhat less energy.

To start with, a high-quality photographic lens with a doublet structure was used to focus the beam. After a few shots, all of the cement between the two lens members was blackened and glass at the junction was destroyed. This lens had a metallic rim. When a rimless doublet lens was used, the two components flew apart.

When the pulse-train laser beam was focused into the interior of polystyrene or lucite blocks, a simple disc-like growth appeared, at right angles to the beam. The disc was black and was in fact a fracture in the block. Microscopic examination showed the disc was made up of blobs of carbonized material, accompanied by trailing fractures.

When the high-power Q-spoiled beam was focused into blocks of these materials, a dark streak in the direction of the beam appeared. This too was made up of blobs of carbonized material. In addition, what looked like a bubble void formed in the center of the streak. The examination further showed that the black blobs were carbonized material in thin disc-like fractures, less than 0.5 mm across.

- **Effect on plexiglass**—In plexiglass, the pulse-train laser beam produced a similar effect to that produced in the two previous materials. However, the blackening was barely apparent. Just a slight brownish trace could be seen, and there were fewer trailing fractures. Again a void was produced. But instead of looking like a bubble it looked like a bullet hole.

When a giant pulse was focused into a block of this material, a completely different effect resulted. No blackening could be seen with the naked eye. Instead there was star-shaped damage with an axis along the beam path. Under a microscope this showed up as a family of discs radiating out from the path of the beam. A diffused bubble region could also be seen in the center.

When the laser pulse-train was focused into glass, a fused bubble in a fracture at right angles to the beam was produced. Focusing a Q-spoiled beam into the glass produced a bubble along the path of the beam with disc fractures radiating out from it.

- **Fractures glass**—To find out the nature of the glass damage, Davis focused the giant laser beam on to the junction of two blocks of glass with optically flat interfaces.

Passage of a laser pulse produced a rupture directly through the junction and the blocks fell apart. In the block first traversed by the laser beam, a void of about 0.75-mm diameter was produced. In the second block, a cavity with a neat stack of powdered glass was found.

"The glass is fractured into tiny fragments, I'm sure, due to the strength of the electric field in the beam when it is concentrated down," said Davis. "At larger energies you would not have the sample left to work with."

Davis pointed out that the laser energies he was using were quite low in comparison with some proposed laser systems. "With energies of 100 joules and 50 megawatts, you don't need to focus down to have the same destructive potential."

Confirmation of Davis' experimental findings was given by T. P. Vogl, of Westinghouse Research Labs, where similar work has been carried out. Vogl agreed that the most likely cause of the damage in the materials was the extremely high electric field strengths in the laser beam.

• **Photography**—Laser photography has been suggested as suitable for nanosecond events and ultra-bright objects such as plasmas.

Dr. G. B. Parrent, senior physicist, Technical Operations Research, Inc., sees more to the problems of laser photography than developing more durable optical parts. Parrents said, "If the optical system survives the blast (of high light energy), you may not like the picture anyway."

In his presentation, Parrent showed mathematically that a photograph of a sharp edge taken in coherent laser light gives a false indication of the position of the edge. The amount of edge shifting varies with what you are photographing. Spurious fringes are also produced parallel to the main image of the edge.

These theoretical findings have been confirmed experimentally.

Parrent said these are not diffraction effects, but come about because of the non-linear nature of laser systems. The effects can reduce-optical resolution by half, in comparison with the resolution obtained with non-coherent light.

• **Reduced resolution**—In discussing the effect of laser spatial coherence on image resolution, Parrent pointed out that any detector in a system using coherent illumination makes the system inherently non-linear.

Non-linearity arises because image formation is linear in electric field amplitude, while image detectors produce outputs linear with respect to intensity. Because these quantities are approximately related by a square law, non-linearities are inevitable.

Resolution gives a useful index of performance of laser optical systems. "However, you cannot give a unique answer to the relation between resolution and degree of coherence," said Parrent. This is because a non-linear system responds in different ways to different objects.

If the object is a square wave—such as a series of uniform alternating black and white lines—the resolution of a lens system viewing the object under coherent light will be half that achieved when the object is illuminated under incoherent light.

Resolution of a sine wave object is independent of the degree of coherence of the illuminating light.

Calculation of the just-resolvable separation between two points for various degrees of coherence, shows that there is an almost linear relationship.

• **Sharpness lacking**—The most striking findings concerned the images formed from objects with a sharp edge. A razor blade illuminated by conventional fluroescent lamps, for example, can be photographed as a farily sharp edge. But under coherent light, the line of maximum density of the edge image is shifted, and a series of light and dark bands parallel to the edge is produced.

When an attempt is made to photograph a standard resolution chart (a collection of arrays of black bars of various widths) under coherent light, a variety of detrimental effects appear. Spurious resolution of close-spaced bars takes place, numerals identifying the bars are broken up, and the corners of large bars become round.

These are not diffraction effects attributable to smallness of the illuminating source. If a ground glass screen is placed between the laser and the object to be photographed, the image is not improved. Quite the reverse, scattering of coherent light by the screen gives a distribution of speckles of light across the image, in addition to the other effects.

Attempts to view the object by reflected coherent light produces a "contour map" effect superimposed on all the other effects.

Although they degrade resolutions, some of these effects might be useful in other ways. By examining a speckle effect, for example, you can discover a lot about the statistics of the scattering surface. This might be used to investigate the structure of a weakly-scattering atmosphere.

Similar effects to the edge shift and spurious fringes, which mar the spatial resolution of an edge, could appear when attempting to resolve the time of arrival of the leading edge of a laser pulse reflected from a complex target. Provided there is only one simple reflecting surface within the coherence length of the laser beam, problems are not likely to arise. But if there is more than one reflecting surface within the coherence length, a number of complex non-linear effects can be expected. ■

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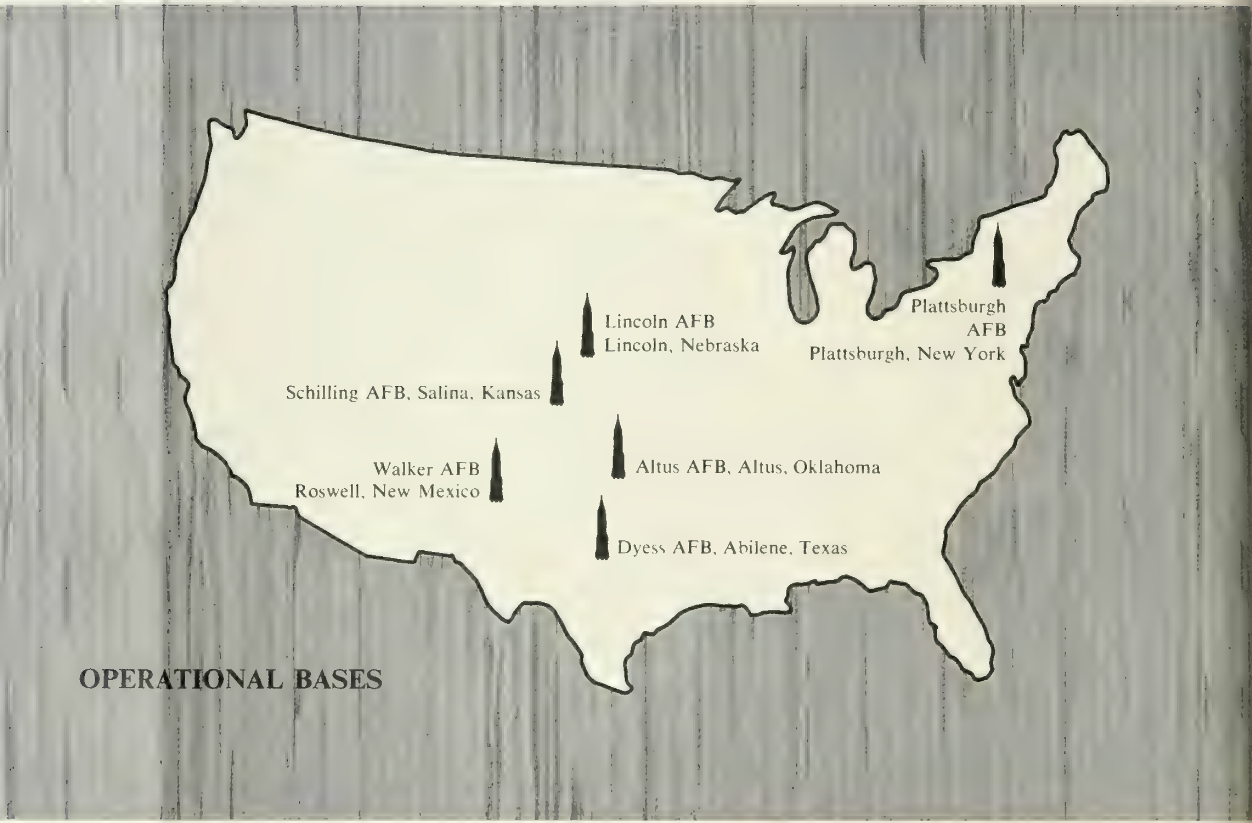
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Marquardt Preparing for Big Sales of Roksondes

Company feels growing world meteorological activity, rocket improvements will sell system based on Loki-Dart

by Willard E. Wilks

VAN NUYS, CALIF.—Marquardt Corp. has completed performance and cost improvements in its *Roksonde* sounding rocket in anticipation of a worldwide small meteorological rocket market five to 10 times its present size.

Rudy Dettwyler, program manager of Marquardt's Atmospheric Data Systems, says several factors are contributing to a big increase in the meteorological sounding rocket field over the next few years.

Most of the hope is pinned on growth of the World Meteorological Organization (WMO) and formation of a World Synoptic Network, in which all nations would participate in gathering and exchanging meteorological data on a much more extensive and faster basis. Cooperation in the network during the International Quiet Solar Year program is expected to provide the impetus for the market growth Dettwyler forecasts.

"WMO members are expected this fall to identify what their contributions will be to the IQSY and to world meteorological data as a whole," he told MISSILES AND ROCKETS. "The United Nations has agreed on a resolution to support WMO in the establishment of a World Synoptic Network. This is defined in the UN charter as a specific mission."

- **Gearing up**—Dettwyler says Marquardt looks to these developments plus recent cost and performance improvements in its *Roksonde* series to boost a market that has been lagging for the past 2½ years. Improvements in the single-stage rocket, basically the *Loki-Dart* antiaircraft system taken over by Marquardt and modified for workhorse meteorological use after the antiaircraft weapon was cancelled, include:

—A 25% boost in altitude performance through use of a higher-energy solid propellant with no hardware configuration changes.

—Increase in reliability from some 60 to 95% as the result of a major quality-assurance manufacturing program.

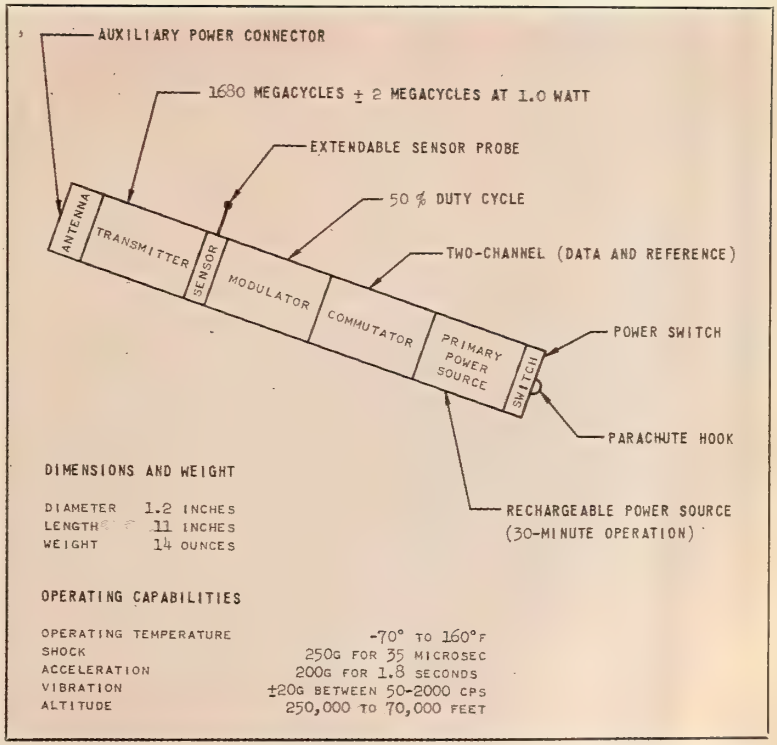
—Development of an active payload—a 14-oz. miniaturized telemetry package to gather temperature, pressure, density and ozone data.

- **Choise of two**—The *Roksonde* is now available in two propellant versions. The 200 model series utilizes a specific impulse of 212 sec. (as originally developed by Jet Propulsion Laboratory and Army), and can reach 200,000 ft. The 250 model, with 250-sec. impulse, can take a payload to 300,000 ft. Available passive payloads include chaff, a 7.6-ft. parachute metallized to reflect tracking radar, a balloon, and metal spheres. The 200-C (chaff) version is the Army's AN/FMQ-6 wind-sensing system. Payloads are carried in the dart.

The new instrument package, which transmits an RF signal on descent while tracking of the parachute provides wind information, is 11 in. long and 1.2 in. in diameter.

Marquardt, with a single-stage vehicle that can reach 300,000 ft., combatting high wind shears with a speed of Mach 5-6, feels it can capture a sizable portion of the foreign market. Emphasis is on simplicity. Ground support equipment is simple and easily transported. The firing panel is carried in a small suitcase, and the launcher is a tube mounted on a tripod that can be hand assembled on any level location in minutes. Tracking radars are carried in a two-wheel trailer.

"The improved version is less expensive than models of two years ago," Dettwyler said. "It out-performs anything available for its size and mission. There is no single-stage rocket that can compete with the 250 series and weigh only 30 lbs. Some of the long-range planning we have done on producibility shows we can get the price down to $200-$300 with sufficient quantities ordered."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BLOCK DIAGRAM of instrumentation package of Marquardt's 200 series Roksonde. With specific impulse of 212 sec., rocket has top range of 200,000 ft.

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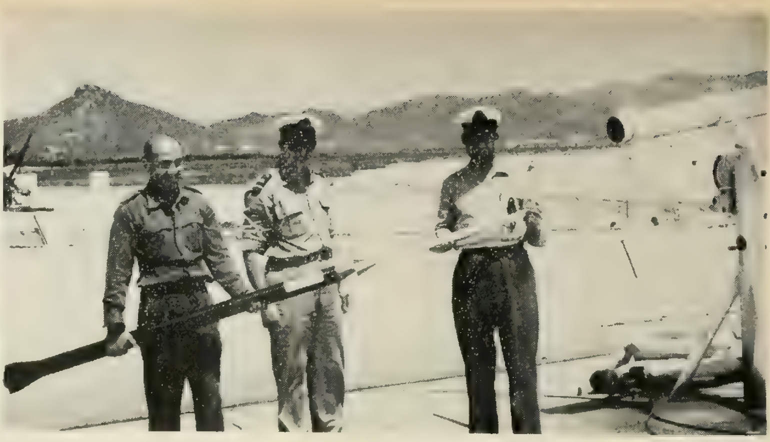


ITALIAN LAUNCHING crew that conducted successful tests with nine instrumented 200 series Roksondes in Sardinia recently. Italy may order 60 units as result of tests.

- **European potential**—Within the past two months Marquardt completed firing of nine 200 series rockets in a $20,000 evaluation program on Sardinia for the Italian government. The tests, uniformly successful and completed in six days, anticipate Italy's selection of a system for high-altitude measurement during the ISQY, and could bring Marquardt an order for 60 units.

Dettwyler sees more European business in the immediate future: "The Europeans are telling us they would like to plan a five-station synoptic network throughout Europe for daily soundings. WMO and other international groups advocate it. This five-station market probably would average 1,500-2,000 soundings a year—running an average of $2 million annually if they were using *Roksondes*."

Looking beyond this, and noting WMO membership, Dettwyler believes the situation looks good for establishment of a World Synoptic Network.

"We are now getting meteorological data from throughout the world. There are about 250 stations which today are launching two weather balloons a day. Looking at the potential increase in business to industry as a whole, I would forecast—based upon successful integration of WMO—between 5,000 and 10,000 soundings a year worldwide. But we are hoping to form a network that uses a standard for rapid interchange of data. This process is being streamlined in the new organization. Data is of no use a year or two after it is obtained."

- **Selling job remains**—But use of the meteorological rocket still must be sold.

"The majority of sounding rockets were created as a backstage by-product of many of the absolete military rockets," Dettwyler said. "They were low-priority. People in meteorological research couldn't get funds. But the meteorologist now is finding himself in the missile business. He would like to obtain more data with sounding rockets. But he has a hard time selling his government on it."

Marquardt officials believe the meteorologist's economic value "has come to a focal point in the last year and a half. If he had the proper information, obtained from a world network using sounding rocket techniques, he could have prevented many major expenses in our missile program. One of the recent *Mercury* launches encountered serious delays due to meteorological limitations. In other important areas, from the airline business to agriculture, money could have been saved."

Meteorologists can make short-range forecasts with about 90% accuracy, Dettwyler pointed out, "but going beyond a few days, his accuracy is less than 30%. Worldwide accumulation of data using latest techniques could advance the state of the art. . . ."

With growth in the market, competition also can be expected to increase, including that from European companies, such as French (M/R, July 8, p. 25) and British.

"The British are trying to come up with a low-cost meteorological rocket, but their program seems slow and not too promising," a Marquardt official said. He believes Europeans "must be convinced by us that they should put their money into new research areas instead of developing their own sounding rockets. With improvements in production methods, we can get our cost down for them."

Dettwyler looks for continuing product improvement to help the market grow. "For instance, a sounding rocket that consumes itself after doing its job, rather than falling on populated areas, could be used from every airport." ■

Astronaut Proficiency Plan Proposed

NASA design aired at G&C conference; twin-gyro stabilization, gimballess inertial unit, lunar radar concepts also discussed

Boston—NASA scientists working on a scheme to maintain astronaut pilot-proficiency during long-duration flights have designed an extremely lightweight, on-board simulator system which can be integrated within contemporary spacecraft displays, sensors, and flight control systems.

Designers at Langley Research Center say hardware efforts, studies, and simulations so far indicate that the spacecraft-integrated system approach is superior to either a separate package simulation system or a hybrid approach, which would require certain display multiplexing that might compromise mission success.

NASA's Dr. R. T. Saucer and Richard Reid, reporting to the recent American Institute of Aeronautics and Astronautics conference on Guidance and Control (M/R, Aug. 19, p. 36), pointed out that many spacecraft mission phases are single events which occur once per voyage after relatively long periods of orbital flight.

NASA officials said that though a small, reliable flight simulation system suitable for orbital flight was developed by Minneapolis-Honeywell for possible use in Project *Mercury*, the system was ruled out because of the weight factor. Gross weight was less than 10 lbs.

A hybrid system, in which some simulation hardware, including computer and displays, is tied into operational flight systems, would reduce the weight factor, the scientists said, but it would raise a more critical problem—it would require multiplexing displays between the simulator and spacecraft flight systems.

- **2-lb. system developed**—NASA says it has now designed an integrated system which eliminates the computer and displays, using operational flight system equipment, and has an estimated total weight of less than 2 lbs.

The system consists of three random-function generators with a bandwidth of approximately 0-10 mc, low-pass filters, three transistorized summing amplifiers, and a battery power supply.

Depending upon control inputs, differences between disturbances and control functions are applied to the spacecraft to generate vehicle rates and attitudes which are sensed by spacecraft sensors and displayed on on-board displays.

An analog simulation of the system reportedly has been carried out at the Langley Rendezvous Docking Simulator "and in all respects proved to be a satisfactory simulation."

For a system to be effective and not take on the undesirable characteristics of the other approaches, the NASA team stressed the importance of system design, "which must be truly integral with spacecraft design."

Particular attention must be devoted to the increased requirement for on-board consumables associated with the reaction control system and the additional running time for automatic flight control systems.

- **Twin-gyro stabilization**—Another NASA group, research scientists from Ames Research Center, reported to the conference results of a NASA investigation into attitude stabilization of large space vehicles, primarily during mid-course flight phase, using twin gyros as torque sources.

The NASA scientists said that with a twin-gyro controller for each axis, the gyroscopic cross-coupling inherent in a single-gyro system is eliminated, thereby allowing large gimbal angle deflections so that a major portion of the momentum stored in the gyros is available for transfer to the vehicle. The elimination of cross-coupling also permits use of an independent control system about each axis, facilitating introduction of the pilot into the control loop.

In studies completed at Ames, two control systems were investigated—an automatic closed-loop system and a pilot-operated system. NASA said it was demonstrated that an automatic twin-gyro system can stabilize a large space vehicle to within ½ sec. of arc.

In a manually controlled operation, they reported, a pilot was able to stabilize the vehicle to within ±5 secs. of arc.

The scientists also added that in the Ames studies, the basic weight of a reaction control system (RCS) capable of attitude stabilization to about 5 sec. of arc was about equal to the weight of a twin-gyro system capable of ½-sec.-of-arc stabilization.

Furthermore, they stressed, as the time required for each system operation was extended beyond a few hours, the twin-gyro system showed a significantly lower weight than the RCS, primarily due to the twin-gyro solar array-battery power system as compared with the increased fuel, tank size, and solenoid-valve power demands of the RCS.

- **MIT gimballess IMU**—Two MIT staff engineers, noting the move toward reduction in the number of mechanical gimbals associated with inertial guidance systems, said that the next step in inertial systems may be the complete elimination of gimballing from inertial measurement units (IMU's).

The reduction in number of IMU gimbals has in general been made possible through improved digital computer techniques and development of small, reliable computer packages.

From most current three-gimbal design, the next step, the engineers report, would be to replace them completely with computation which isolates analytically a coordinate frame from vehicle rotation, or which accounts in some other way for the fact that the coordinated frame in which the inertial instruments are operating is rotating with respect to inertial space.

In essence, this step, the MIT engineers report, would leave the IMU in the form of a package of inertial instruments mounted directly to the vehicle.

They point out that there is still doubt concerning how these instruments would perform in some special missions. Though "it seems certain that a gimballess IMU will not be capable of the same low levels of uncertainty as the gimballed system, there must be a set of missions for which GIMU performance will be acceptable." In the latter case, the GIMU would offer advantages in virtually every aspect of system design—weight, space, power, and reliability.

The MIT engineers, Robert M. Bumstead and Wallace E. Vander Velde, discussed only broad possibilities for system design, which, they stress, is highly influenced by actual mission parameters.

The general configuration, employing a GIMU, may take either of two basic forms—computing in a stabilized coordinate frame or computing in the body coordinate frame.

The basic choice in design, they report, is the type of inertial instruments to use. The most compact instrument assembly is a set of pulse-rebalanced instruments such as three single-degree-of-freedom pendulous accelerometers and three single-degree-of-freedom integrating gyros, all operating with pulse-torquing feedback loops. The feedback torque must be scaled to accommodate the maximum vehicle acceleration in the case of the accelerometer and the maximum vehicle angular velocity in the case of the gyro.

A further choice in dealing with pulse-rebalanced instruments is binary or ternary torquing. Binary is simpler, they state, but the instrument exhibits a limit cycle even in the absence of input.

The alternative to the use of torque-rebalance gyros, the engineers report, is the use of single-degree-of-freedom platforms for the gyros. The most attractive configuration of the kind employs a set of six pendulous integrating gyro accelerometers (PIGA), two on each axis, arranged so they rotate in opposite directions in response to acceleration inputs.

The sum of the outputs of the two PIGA's on each axis is then a measure of the integrated angular velocity about that axis, and the difference of the outputs is a measure of the integrated acceleration.

This arrangement probably has a greater performance potential than torque-rebalanced instruments, the engineers report, but the package will be larger, heavier, and will involve servo loops.

The type of computer to be used with a GIMU system is dictated by the cycle time requirement. If time is long enough to allow use of a flexible general-purpose digital computer, this is probably the best choice, according to the MIT presentation. In some missions, it pointed out, gyro sampling time is so short that a digital differential analyzer would then be required.

- **Lunar radar designs**—Radar techniques associated with the lunar landing also came into considerable attention during the conference.

For example, a team of engineers from General Precision, Inc., Pleasantville, N.Y., presented the case for applicability of Doppler radar velocity techniques in various phases of the lunar mission.

It is reported that this type of radar has already been chosen by NASA to play a key role in the LEM landing and recovery operation (M/R, July 15, p. 26).

The engineers emphasize that significant portions of many space missions, and particularly the LEM mission, are free-fall, where an inertial sensor is incapable of providing velocity data.

Further, they add, as powered portions of the flight near the lunar surface are undertaken, the insufficiency of data pertaining to center-of-mass location, gravity "noise," topographical variations, and the exact location of fix-points will make it necessary to employ a Doppler velocity sensor. These devices, they state, are influenced only slightly or not at all by such factors.

GPI examined six phases of the lunar missions and concluded that four of them would benefit from Doppler methods. In the latter portion of powered descent to the lunar surface, Doppler is most suitable, they reported. Ranges, accuracies, and time constants are very compatible with the capability of Doppler measurements of microwave energy back-scattered from the lunar surface.

Depending upon the degree of uncertainty with respect to lunar gravity field, a Doppler system, as opposed to an inertial sensor, may provide a better measure of injection velocity required for lunar rendezvous. A cooperative Doppler radar capable of measuring range and relative velocity is also described as "ideally suited" for other lunar rendezvous phases, mid-course correction and final braking phase. A radar-transponder system with a nominal 100-mi. range; and range, velocity, and angular velocities of ½% could be provided, GPI said, in a ½-cu.-ft. package weighing 20 lbs. and requiring 40 watts power.

- **GE's bi-static radar**—Two General Electric Co. engineers from the firm's Electronic's Laboratory in Syracuse proposed use of a bi-static or semi-active correlation radar as a means to sense spacecraft velocity and altitude with respect to the lunar surface at much higher altitudes than is possible with conventional radars.

With a bi-static radar, the transmitter and receivers are at separated locations. Actually, the transmitter is on Earth, and must be powerful enough to create an "artificial atmosphere" of microwave energy adjacent to the visible side of the Moon. This is used as a medium for velocity sensing by spacecraft receivers.

This electromagnetic atmosphere, the GE engineers report, is actually an irregular distribution of field-strength resulting from the constructive and destructive interference between the direct wave from Earth and the reflected wave scattered from the Moon. Since this irregular field strength pattern is very nearly stationary with respect to the Moon, the velocity of the vehicle as measured by sensing the pattern is, in effect, the velocity with respect to the Moon itself.

Using a DSIF-type transmitter, the engineers state, the sensor can be operated at altitudes up to at least 1,000 mi. above the Moon, with required bandwidth and receiver noise figures.

Deriving velocity information by sensing the field-strength pattern involves cross-correlating the signals received by separate antennas on the spacecraft. If two antennas are placed on the vehicle so that one follows directly in the path of the other, then both will sense the same irregular field-strength fluctuations. However, the signals from the two antennas will be separated by a time-delay equal to the distance between the antennas divided by the speed of the vehicle. Cross-correlation provides a means of measuring this time delay, and since the antenna spacing is known, the speed can be computed.

By using an array of antennas instead of just two, the direction of the velocity sensor with respect to the spacecraft can also be sensed.

In addition to velocity sensing, the GE engineers say the same equipment can also provide altitude sensing, by modulating the Earth-based transmission with a waveform having an autocorrelation function. Time-sharing and signal-processing methods should allow use of the same gear and simultaneous operation, it was reported.

GE says early calculations show the altimeter could function as far as 4,000 mi. from the Moon. Basically, spacecraft would measure delay between arrival of direct transmission and reflected transmission from Moon. Knowing the angle of the direct signal with respect to the local lunar vertical, altitude could be computed. ■

Gemini, Apollo To Demand Tried-and-True Instrumentation

More sophisticated data must await later programs; panel at IEEE meeting details improvements needed, work under way

by Heather M. David

BIOMEDICAL INSTRUMENTATION throughout the *Gemini* and *Apollo* missions will reply on proven operational techniques.

The type of information gathered may not be all that research physiologists would desire. As in *Mercury*, system restraints will make the main concern whether the astronauts are in a go/no go condition.

A panel of top NASA, Air Force and private research specialists who met at a recent session of the Institute of Electrical and Electronics Engineers (IEEE) stressed the importance of developments along these lines:

—Miniature sensors and techniques for applying them which will eliminate constraint or irritation.

—Elimination of artifacts in the signals by improved equipment.

—Improvement of signal presentation methods, so that vital real-time information is given in a compact fashion, but complete data is stored for post-flight research.

Further down the line, perhaps, is the search for more meaningful physiological variables that can be measured and easily transmitted. Dr. Tom Nevison of the Lovelace Foundation said his group is working on a number of new developments, including implanted sensors in animals and new surface electrodes in humans.

One project, endoradiosondes, shows great promise as sources of information about the temperature, acidity and other conditions of the gastro-intestinal tract. The endoradiosonde is a small "pill," composed of a variety of elements, which is swallowed. The electrical signal can then be matched with known signals to diagnose conditions.

Nevison also outlined developments in new signal conditioning equipment, new silicon temperature sensors, and the use of biological potentials to transmit

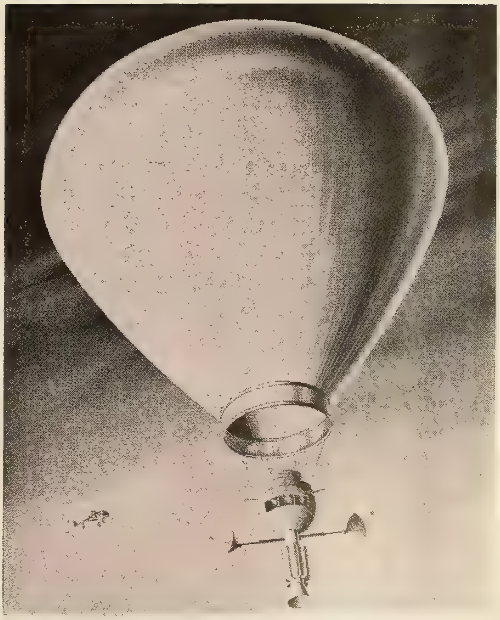
Venerable Heated-Air Balloon Studied as Space Recovery System

HUGE HOT-AIR BALLOONS would be used for recovering space vehicles under a concept being studied for NASA by the Ordnance Division of Honeywell.

The concept, shown in artist's drawing at right, involves four main elements—a parachute for initial orientation and deceleration of the payload, the balloon, gas burners to inflate and sustain it, and a control system to initiate and sequence the recovery cycle and regulate burners.

Nicknamed "Paravulcoon"—a combination of parachute, Vulcan (the god of fire) and balloon—the system was conceived by Raven Industries, Sioux Falls, S.D., which will be major subcontractor to Honeywell under a Langley Research Center contract.

Honeywell says the Paravulcoons are designed to recover almost any space vehicle and bring it undamaged back to Earth. The initial study calls for wind-tunnel testing on small-scale models at Langley, followed by cold-drops of 1,000-lb. payloads to test balloon deployment and inflation.



THIS 17th-Century representation of planetary orbits, based on ancient Greek observations, apparently relied more on logic and aesthetics than on fact. Today's demands are for ever-increasing information accuracy, especially about the physical and operational environments of manned space flight.

If *you* understand the environments of space vehicles, and your background includes guidance, navigation, celestial mechanics, flight control, attitude control, or space data processing and communications, you are invited to investigate the many career opportunities available at IBM.

The IBM Space Guidance Center, as guidance system integrator for the Gemini program, is developing the Gemini computer as well as improved docking/retrieving and re-entry techniques for NASA. The Center is also developing the guidance computer and related equipment for the Saturn program. IBM's on-board data processor for the Orbiting Astronomical Observatory is further evidence of the professional level of accomplishment by our space technology scientists and engineers.

Current studies at the IBM Space Guidance Center—in central New York State, bordering on the Finger Lakes vacationland area—include re-entry guidance and control, and space station data management and communications. IBM is an Equal Opportunity Employer.

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physiological information.

- **Cardiovascular model**—Dr. Michael Wilson, of the Physiology Department of the University of Kentucky, made a presentation describing a mathematical analog of some of the dynamic functions of the heart.

Wilson said his group was looking at some new measurements which will give the physician a more direct idea of the condition of the heart. He also pointed out that the model will aid the physical scientist in understanding the physiologist's work.

- **New definitions**—Both Lt. Col. Stan White, late of Manned Spaceflight Center, Houston, and now with Aerospace Medical Division, Brooks AFB, Tex., and Dr. Duane Catterson of NASA stressed the difference between spaceflight and clinical medicine.

If the astronauts' measurements—such as heart rate—were to be interpreted by clinical standards, flights often would be terminated. The most useful tool, they say is the astronaut's own history from simulations and exercise tests.

For instance, the decision to allow Astronaut Walter Schirra to continue his flight while his suit temperature was high was based in part on a comparison of his physiological measurements with those on his records. Since they were found to be within acceptable levels for him, the flight was not aborted.

- **Future trends**—A new type of equipment may evolve for the multi-man, several-month *MOSS*-type missions, said Dr. Charles Battig of North American Aviation.

He forecast an on-board, weekly checkup with clinical equipment. Battig pointed out that in the present state of the art there are: a 50-lb., 500-watt X-ray machine; transistorized equipment for radioisotope tracing; biochemical test techniques which allow complete tests of one drop of blood; and new developments in gas chromatography.

- **PIAPACS**—Lear Siegler, contractor for the most sophisticated of all biomedical monitoring systems—the Psycho-physiological Information Acquisition Processing And Control System (PIAPACS)—described progress on the system. The NASA project will monitor both the astronaut and the environment, and process data.

At present, said Dr. Joseph Miller, Lear Siegler is working on problems of sensing and predicting possible changes in condition. He said the group is aiming towards fewer sensors—and no implanted sensors—and less obtrusive equipment.

PIAPACS, others pointed out, is a research tool and goes far beyond operational requirements. ■

The Industry Week

New Firms and Divisions

Radio Corporation of America has realigned its Defense Electronic Products divisions "to bring related or similar projects and activities into closer coordination and to extend the use of skills in these areas." RCA's Data Systems Div., Van Nuys, Calif., will be merged with the Aerospace Communications and Controls Div. to form a new division known as the Aerospace Systems Div., with headquarters in Burlington, Mass. Both divisions have been engaged in data processing systems, checkout and related programs. The Communications and Controls Div., Camden, N.J., will be merged with the Surface Communications Div., Camden, to form the Communications Systems Div. . . . *Dow Corning Corp., Midland, Mich., has formed an aerospace materials group to improve liaison and speed technical service and development to the missile/space industry. Dow Corning's line of materials includes sealants and ablatives, diffusion pump fluids, resins, silicone rubber, high-temperature hydraulic fluids, additives for high-temperature oils, and silicone and fluoro-silicone lubricants.*

Mergers and Acquisitions

International Electronic Research Corp., Los Angeles, a subsidiary of Dynamics Corporation of America, has acquired all assets, personnel and the name of Telemetering Corporation of America, Van Nuys, Calif., a producer of telemetering systems for major missile projects. Telemetering has been a division of Jamieson Industries. It will be moved to the IERC facility in Burbank, Calif., and become a part of the company's operations, adding a telemetering capability that IERC did not have before. IERC is a manufacturer of heat dissipating devices, precision electronic measuring instruments, and other instruments and components.

Company Representatives

Packard Bell Computer, Los Angeles, has moved its southeast district headquarters to Huntsville, Ala., and is opening an office in the Cape Canaveral area as part of a general expansion of sales coverage. The office will cover Alabama and western Tennessee as well as NASA installations in Louisiana and Mississippi. Sales engineer Harvey Eckenrode will soon establish the permanent office in the Cape Canaveral area. Both offices will handle marketing of the PB250 and PB440 digital computers, the TRICE digital differential analyzer and data systems capabilities and equipment including converters, digital circuit modules and amplifiers. . . . *Kitchen & Kutchin, Inc., Lexington, Mass., and West Hartford, Conn., has been appointed by Electron Products, a division of Marshall Industries, Monrovia, Calif., to handle sales in the New England area. The firm will represent the complete Electron line of precision capacitors in Massachusetts, Connecticut, New Hampshire, Maine, Vermont and Rhode Island.* . . . Liberty Electronics Corp., Inglewood, Calif., has been awarded a Motorola semiconductor distributor franchise for the Los Angeles area. A subsidiary of Wyle Laboratories, Liberty occupies an 18,000-sq.-ft. facility and maintains a staff of eight outside salesmen whose territories extend from Vandenberg AFB, Calif., to the southern tip of Orange county. The firm is to maintain a complete inventory of all popular Motorola semiconductor devices, including silicon and germanium transistors, rectifiers, silicon controlled rectifiers, zener diodes and power transistors. Liberty will also be a factory source for Motorola's MECL integrated circuits as well as a line of over 400 rectifier stacks. . . . *Clary Corp., San Gabriel, Calif., has opened a West Coast sales office in Los Angeles. The office, under the direction of Hal Roach, will serve the Southern California area.* . . . NAECO Associates, Inc., has been named sales representative for Dynatronics, Inc., in the mid-Atlantic states and selected military establishments. Dynatronics, Orlando, Fla., makes electronic systems and equipment for collecting and processing missile/space data. . . . *The Scionics Corp., Northridge, Calif., an electronics firm, has appointed sales representatives for Florida, Georgia, Alabama, southern California, Nevada, metropolitan New York, and northern New Jersey. Named were: Willett-Burnside Co., Clearwater, Fla.; Engineered Sales Applications, Sherman Oaks, Calif.; and Hemmel Co., Caldwell, N.J.*

International

National Research Corp., Cambridge, Mass., has become exclusive U.S. distributor for tungsten and molybdenum products produced by Metallwerk Plansee of Austria. MP is the leading European manufacturer of refractory metal products. NRC produces tantalum and tantalum-tungsten and capacitor grade tantalum powder. . . . *Thwing-Albert Instrument Co., Philadelphia, and A.B. Lorentzer and Wettres, Stockholm, have reached a mutual assistance agreement for complete exchange of technical information and instrument sales-service. Thwing-Albert has acquired all sales-service rights to L & W instruments in the U.S. and Canada, and L & W will represent Thwing-Albert throughout Europe. A number of Thwing-Albert instruments will be manufactured by Lorentzen and Wettres in Europe and Thwing-Albert will manufacture L & W instruments in the U.S.*

Facilities

International Microwave Corp., Burlington, Mass., has tripled facilities to accommodate increased activities in the field of solid-state devices. The company will move into a new facility Sept. 1. IMC is a wholly owned subsidiary of Microwave Associates, Inc., and specializes in the manufacture of high frequency microwave components, such as tunnel diode oscillators, amplifiers and microwave receiving systems.

—contracts and procurements—

AWARDS

AIR FORCE

$2,476,945—**Acoustica Associates, Inc.,** Los Angeles, for development and production of a system for measuring and mixing rocket propellants in flight in a space launch vehicle model to be used until 1970.

$240,000—**International Data Systems, Inc.,** Dallas, for ground electronic equipment to be used in space booster and satellite applications.

$105,296—**Texas Instruments, Inc.,** Dallas, for an investigation of geophysical methods for finding water on the Moon.

$44,788—**Electric Storage Battery Co., Missile Battery Div.,** Raleigh, N.C., for *GAR* weapon system batteries.

ARMY

$7,000,000—**Belock Instrument Corp.,** Washington, D.C., for production of 34 *Hawk* missile trainers.

$7,000,000—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for continued research and development of the *Shillelagh* surface-to-surface, tank-mounted missile system.

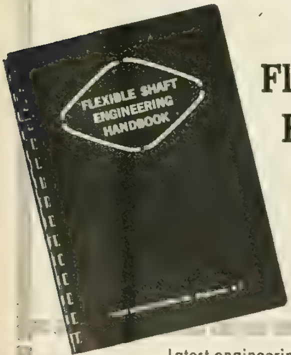
$1,440,000—**Beech Aircraft Corp.,** Wichita, Kan., for production of Model 1025 *Cardinal* target missiles.

$500,000—**Martin Co., Orlando Div.,** Fla., for modification of some of the Martin-developed BIRDIE systems so that target data for all or any part of the missile strength of a single command can be viewed on any one of scanning consoles at the commander's option.

$262,500—**National Co., Inc.,** Melrose, Mass., for production engineering of the cesium beam tube.

$135,790—**Sperry Rand Corp., Sperry-Utah Co.,** Salt Lake City, for *Sergeant* missile ground support equipment (two contracts).

$49,996—**Hughes Aircraft Co.,** Fullerton, Calif., for development, test and continued research and development on the *Mauler* weapon system.



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$43,983—**Douglas Aircraft Co.,** Santa Monica, Calif., for *Nike* repair parts.

$42,359—**Raytheon Co.,** Andover, Mass., for parts and components of chassis type items for NATO-*Hawk* weapon system.

Motorola Inc., Solid State Systems Div., Phoenix, for an advanced design study and development program for thin-film microcircuits and subsystems.

NAVY

$4,000,000—**Raytheon Co., Missiles & Space Div.,** Sudbury, Mass., for the manufacture and delivery of *Polaris* MK 2 electronic assemblies.

$1,500,000—**Collins Radio Co.,** Cedar Rapids, Iowa, for communications systems.

$941,793—**Atlantic Research Corp.,** Alexandria, Va., for fabrication of inert components for rocket motors.

$720,000—**General Electric Co.,** Pittsfield, Mass., for *Polaris* weapon system guidance simulators.

$600,000—**Beckman Instruments, Inc.,** Fullerton, Calif., for atmosphere monitoring equipment for the U.S. nuclear submarine fleet.

$598,844—**Chromcraft Corp.,** St. Louis, Mo., for LAU-3/A rocket launchers.

$550,000—**Interstate Electronics Corp.,** Anaheim, Calif., for *Polaris* instrumentation.

NASA

$511,300—**Geophysical Institute of the University of Alaska,** College, Alaska, for operation and maintenance of the Minitrack network facility.

$470,000—**Raytheon Co.,** Norwood, Mass., for design and fabrication of a frequency modulation transmitter.

$362,000—**G. T. Schjeldahl Co.,** Northfield, Minn., for fabrication of *Echo* A-12 mylar spheres.

$194,405—**International Business Machines Corp.,** Houston, for No. 7040 digital computer system.

$187,712—**Sperry Gyroscope Co.,** Great Neck, N.Y., for development of an operational computer program for deep space orbit determination.

$158,000—**North American Aviation, Inc., Columbus Div.,** Columbus, Ohio, for construction and installation of a g-seat dynamic flight simulator.

$133,839—**Scientific-Atlanta, Inc.,** Atlanta, for instrumentation, installation and testing of Manned Spacecraft Center radar boresight range.

$129,197—**General Electric Co.,** Philadelphia, for a research program for obtaining design data required to effectively fabricate an integrated thermionic test module.

$97,750—**The Ballinger Co.,** Philadelphia, for A/E design and preparation of specs for an electronic instrumentation laboratory.

$86,764—**Symetrics Engineering Corp., of Florida,** Satellite Beach, Fla., for an autotracking monopulse telemetry antenna system.

$64,820—**Plasmadyne Corp.,** Santa Ana, Calif., for thermal testing of ablative heat shields.

$61,248—**Harshaw Chemical Co.,** Cleveland, for continuation of present contract for development of large-area thin-film cadmium sulfide solar cells.

$46,250—**Planning Research Corp.,** Los Angeles, for a study of the advanced *Syncom* satellite project.

$36,424—**High Temperature Instruments,** Philadelphia, for service, materials and facilities to develop fabrication techniques and apply them in making cooled and uncooled plasma probes.

Speer Carbon Co., St. Marys, Pa., for the development of a high resistivity paste to be used in a silk screen printing process for producing electronic circuits (undisclosed amount).

Goodyear Aerospace Corp., Akron, Ohio, for a feasibility study and preliminary design of a gravity-gradient oriented lenticular passive communication test satellite (undisclosed amount).

AEC

$340,432—**C.H. Leavell & Co.,** El Paso, Tex., to erect nuclear research reactor facilities at the Nevada Test Site.

INDUSTRY

$2,247,000—**National Co., Inc.,** Malden, Mass., from **Radio Corp. of America,** for delivery of a large quantity of electronic receivers.

Pioneer Program

(continued from page 23)

for range safety reasons. This constrains the orbit from which the spacecraft will eventually escape. With TAT, they note, the second stage can be put into orbit allowing *Pioneer* to coast in about a 100-mi. Earth orbit for as long as needed before firing the third stage for escape.

- **System duration**—*Pioneer* is being designed to achieve 95% reliability for six months of operation in which the communications links will still be useable "with reasonable bit rates;" this corresponds roughly to distances somewhere between 50 and 90 million mi.

The second set of two launchings will probably begin late in 1965 or early '66, and will follow the same pattern and time spread. Payload for this second set has not yet been decided, but many of the experiments will probably be of the same type as the first set. RFP's will probably go to the scientific community before the end of the year for the second flight set, according to NASA.

Experiments for the first two flights have been selected and formal contracts are expected to be signed within a few weeks. No hardware, either satellite or experiment, has been produced to date. First flight models from the experimenters are due in October '64.

Six experiments are planned for *Pioneer*, sharing various priorities in the event booster considerations force payload weight cuts. These packages will measure magnetic fields, cosmic rays, plasma fields, and RF propagation. A seventh experiment, a micrometeorioid detector, is also under consideration with a decision expected this month.

- **Experiment details**—Three experiments hold top priorities—a magnetometer, being developed by NASA's Goddard Space Flight Center, a plasma probe being developed by Massachusetts Institute of Technology, and a cosmic ray experiment designed by the University of Chicago. The next three priority levels are held by a Stanford University RF propogation experiment, a second cosmic ray experiment proposed by the Southwest Research Institute, and a second plasma probe developed by Ames. Designs for the micrometeoriod detector have been proposed by both Ames and Goddard.

Magnetometer—one of the major experiments, this unit, which is expected to be capable of interplanetary magnetic field measurements as low as 1-½ gamma, has put heavy restrictions on spacecraft design. The device will be physically removed from the spacecraft shell, riding atop the antenna boom, but the hoped-for sensitivity necessitates taking some risks with component selection.

Some normally high-reliability components may have to be by-passed in favor of other units that have greater "magnetic cleanliness." Soft iron, some steels, certain component casings will have to be avoided.

NASA points out that just shaking some components in the Earth's magnetic field (as in launch conditions) could induce fields strong enough to interfere. Techniques in wiring and connecting solar panels and other circuitry must be studied to avoid unnecessary current loops. Magnets in redundant TWT's will be positioned so that their fields cancel.

NASA says it will use flux-gate sensors in the equipment, with one sensor set at an angle with respect to the spin axis so that during any given spin it will occupy a mutually orthogonal position.

Plasma probes—both of those proposed, though of different design approach—will do essentially the same thing, according to NASA. They point out, however, that two units are desirable in this area since data interpretation and correlation is complex. The devices will seek data on the static and dynamic character of the interplanetary medium, energy distribution, angular distribution, and fluctuations as a function of time.

The MIT design, using retarding-potential techniques, is said to incorporate a Faraday cup and a split collector. The Ames design uses a curved plate electrostatic analyser with separate collectors providing a total look-angle of about 160 degrees, reportedly about the same as the MIT unit.

Cosmic ray units—in general will look at energy, mass distribution, and fluctuations; however the Southwest Institute package is going to attempt to detect non-homogenity in the direction of arrival. This will be an attempt to establish whether or not there is a slight preferred direction for these events.

RF propagation experiment—will measure the gross parameters of the interplanetary electron content by observing the change in character of a signal transmitted from Earth to the spacecraft. Phase advance and group delay will be measured at two different frequencies, 50 and 400 mc, using the 150-ft. dish at Stanford for transmission and a small linear receiving antenna on the spacecraft. Some DSIF antennas may join in this experiment, depending on spacecraft location.

Micrometeoroid detector—is based on a new instrument developed by Vernon L. Rogallo (see p. 22). ■

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To provide technical support required by Rocket Assembly in areas of methods, tooling, fixtures, and equipment; detailed process studies and design work would be provided through coordination with technical and engineering operations. Responsibilities include manufacturing procedural requirements, acquisition, design and acceptance of tooling, fixtures and equipment; review contracts, drawings and specifications; provide engineers with manufacturing technical systems; assist in creation of cost estimates; review and supervise assembly personnel on assigned production tasks or programs. B.S. mechanical engineering with up to six years experience in field closely related to manufacturing and assembly techniques.

TEST ENGINEER

To plan and design test programs for rocket propulsion systems; prepare schedules and coordinate program to meet schedules; analyze test results and prepare test reports; design mechanical components for measurement systems: plan and coordinate environmental test programs; keep abreast of field of testing and rocket propulsion. B.S., M.S. mechanical engineering or physics with minimum of three years experience, preferably in rocket propulsion field.

GAS DYNAMICIST

To work in areas of gas dynamics and fluid mechanics dealing with problems relating to poly-phase flows, external ballistics, stability and aerodynamic loading of high altitude sounding rockets. Activities will include analytical and experimental evaluation of rocket configurations used in a wide variety of upper atmosphere research missions. Prerequisites are a thorough understanding of aerodynamics through entire speed regions. B.S., M.S. mechanical or aeronautical engineering.

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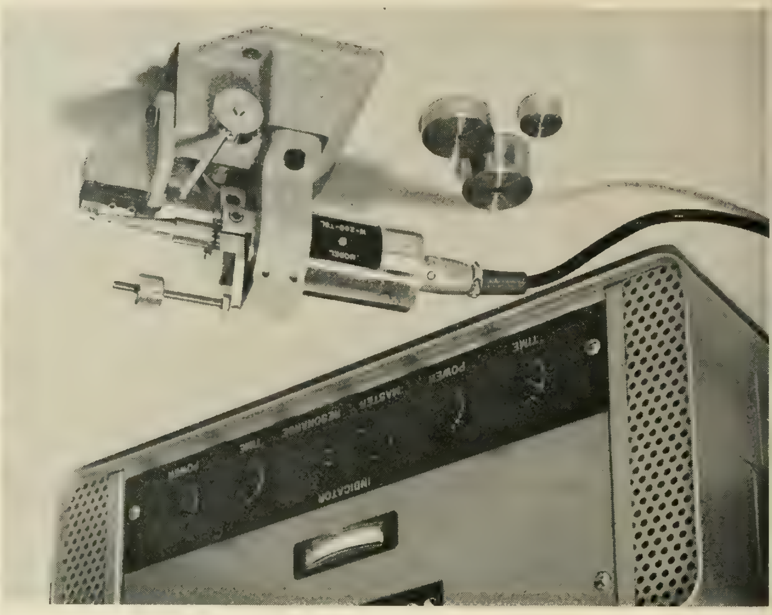


New Product of the Week:

Compact Ultrasonic Welder

Sonobond Corp. is marketing a 20-watt ultrasonic welder. Termed Model W-260-TSL, the welder is designed to handle the smallest weldments and facilitates assembly operations in the transistor and micro-circuit device manufacturing industries. The compact welder is adaptable to micropositioning equipment and is available for installation in standard wire-bonding machines.

The Model W-260-TSL power generator has a visual resonance indicator for proper work setup. Variables ordinarily encountered in ultrasonic devices are automatically compensated for in the new unit. Regulation of the ultrasonic energy delivered to the weld area is accomplished by a manual power control, adjustable over both high and low range. Step switches control power and weldtime to prevent their accidental change and to provide reproducible setup adjustments. Stability of operation to insure high reproducibility of weld quality has been the design foundation for the welder.

Circle No. 225 on Subscriber Service Card

High-Temp Lubricants

Bemol, Inc., is marketing four colloidal suspensions of the extreme temperature lubricant, tungsten disulfide. Tungsten disulfide, which has previously been available only in powdered form, has now been successfully suspended in four carriers. The products are designated: #210 tungsten disulfide water suspension, #220 tungsten disulfide bonded film, #240 tungsten disulfide oil suspension, and #260 tungsten disulfide alcohol suspension. Tungsten disulfide is stable in air to 950° F, exhibits a low oxidation rate in air above 950° F, and is stable in an oxygen-free atmosphere to more than 2,400° F. The tungsten disulfide materials have greater thermal stability than either molybdenum disulfide or graphite, and are applicable to high-temperature metal forming and aerospace lubrication.

Circle No. 226 on Subscriber Service Card

Heating Elements

The Carborundum Co. is marketing a Globar SG spiral heating element that takes up to 3,100°F operating temperatures.

The high-density recrystallized silicon carbide elements withstand severe furnace cycling and are resistant to oxidation in air and corrosive atmospheres including glass vapors, moisture and oxide fumes. Variation from specified furnace temperature is generally less than ±1°C.

Circle No. 227 on Subscriber Service Card

Miniature Silicon Rectifiers

Power Components, Inc., has developed two series of high-voltage, multiple-junction miniature silicon rectifiers, designated as TE series for the triple junction units and DE series for the double junction units. The case outline will meet the JEDEC DO-13 requirements.

The DE series is rated for a maximum of 600 ma at 50°C, and is derated linearly to 0 ma at 150°C, for free air ambients. Peak inverse voltages range from 1,000 to 2,500 volts per single unit.

The TE series is rated for a maximum dc output current of 350 ma at 50°C, and is derated to 0 ma linearly at 150°C for free air ambients without heat sink. Peak inverse voltages range from 1,800 to 4,000 volts for single units.

Circle No. 228 on Subscriber Service Card

Digital Plotters

A series of digital plotters designed for scientific, industrial and military uses where fast, accurate, graphic recording of digital coordinate data is needed has been developed by Electronic Associates, Inc.

Designated the 3110-3120-3130 DATAPLOTTER Series, these units operate both on-line with a digital computer and from card or paper tape readers, and are capable of plotting points, symbols, or lines at speeds as high as 100 points or 70 lines a minute on a 10 x 15-in. plotting board.

The system accepts information in the form of three decimal digits plus sign in both X and Y for points and line end points. Input can be from serial or parallel punched card readers, punched-tape readers, or, as a manual input, from the self-contained adding-machine type keyboard.

Circle No. 229 on Subscriber Service Card

Direct Writing Recorder

A portable two-channel rectilinear direct writing recorder that writes on channels 80 millimeters wide at frequencies beyond 35 cps full scale is available from Brush Instruments, a division of Clevite Corp.

Possible applications of the Mark 280 include spectrophotometry, diffusion, shock and vibration and process quality assurance studies.

Included are solid-state drive amplifiers and preamplifier for each channel, affording sensitivity of 0.5 millivolts per chart division and input range to 250 volts. Inputs are floating and guarded with input impedance of one megohm.

Circle No. 230 on Subscriber Service Card

Copper-Clad Laminate

Developed by Thiokol Chemical Corp. is Panelyte Grade 161-EL, an ultra-thin, copper-clad laminate utilizing one or more layers of a high strength continuous filament, electrical grade industrial glass fabric impregnated with an epoxy resin. This material, which is available in thicknesses of 0.004, 0.008 and 0.012 in., has application for use with multi-circuits.

Multi-circuits provide a reduction of exposed printed wiring surface area per unit component package and afford a composite printed wiring assembly with a flexible volume-to-surface relationship. The weight of such circuit packages is substantially decreased in comparison with the necessary conductive pattern area required in conventionally designed one- or two-sided printed wiring boards. While mechanical strength is essentially reduced only a minor amount, electrical characteristics are equivalent to the base material and conductive surface counterpart in standard panels.

Circle No. 231 on Subscriber Service Card

Microvolter

Ferris Instrument Co., Inc., has available the Model 24-D Microvolter, a signal generator that offers up to 32 switch-selectable crystal-controlled carrier and IF frequencies for citizen's band applications, with an output adjustable from 0.01 to 100,000 microvolts in seven ranges.

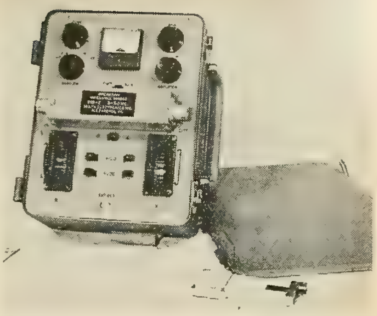
Designed specifically for rapid test and alignment of citizen's band receivers and transmitters, the instrument is equipped with individual crystals for each of the 23 frequencies allocated in the 26.995 to 27.255 mc band, and two crystals (frequencies chosen by the customer) in the intermediate-frequency band from 200 kc to 15 mc. From one to seven additional IF crystals may be included.

A total of seven output ranges are available from three BNC connectors mounted on the panel. The high output connector offers 10,000 to 100,000 microvolts; the medium connector covers 1,000 to 10,000 microvolts. Five ranges, from 0.1 to 1,000 microvolts full-scale, are available from the low connector. All outputs are rated for 50 ohm loading.

Circle No. 232 on Subscriber Service Card

Impedance Bridge

Delta Electronics, Inc., is marketing the Model OIB-2 High Frequency Operating Impedance Bridge that can be inserted directly in any part of a high frequency antenna system to measure the "operating" impedance of radiators, network inputs and transmission line terminals under power. The transmitter, or a high power signal generator, may be used as a signal source. The power rating of the bridge is 1,000 watts.



The OIB-2 is designed for operation on any frequency between 2 and 30 mc. It has a resistance range of ±500 ohms and a reactance range of ±500 ohms.

Circle No. 233 on Subscriber Service Card

Gas/Liquid Purifier

A gas and liquid purifier, designed to protect delicate instruments is now available from the Matheson Co., Inc. The unit removes oil, water, and solid particles through the use of molecular sieves and other special replacement cartridge filters, and is rated for inlet pressures up to 2,000 psig (oxygen, 500 psig maximum).

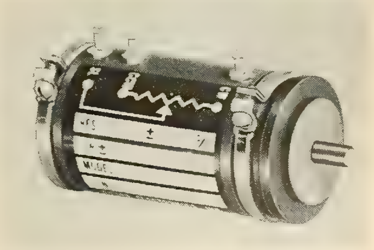
Circle No. 234 on Subscriber Service Card

Potentiometers

A series of precision ⅞-in. dia., ten-turn potentiometers designed for both linear and non-linear functions in complex systems is available from Astro Electronics, Inc.

Operating torque of the 088-10 series is 0.6 oz.-in. as single units and 0.5 oz.-in. for each additional unit. Linearity of ± 0.25% and a resistance range of 10 to 50,000 ohms (±3%) is standard.

Units are designed to meet mechanical and environmental requirements of NAS-710, MIL-R-19, MIL-R-12934, and MIL-E-5272B. Housing material is Daill 5201 (per Mil. Spec. M-18794, type SDG.), which withstands temperatures up to 125°C.



Circle No. 235 on Subscriber Service Card

Battery Charger

Two military-type battery charger models incorporating silicon-controlled rectifier circuitry to increase efficiency as much as 10% and reduce size and weight to 50% less than comparably rated magnetic amplifier equipment have been developed by Hughes Electronics Co.

Built to meet Class R of specification MIL-P-157336C for high impact shock and vibration, these chargers feature drip-proof construction in bulkheads or deck mounting enclosures.

Both models are designed for dual inputs of 440v/three phase or 115v/single phase. Model 14/8-20/2-B5N4 delivers a dual output of 14v at 8 amperes, or 20v at 2 amperes. Model 4030-B6N delivers 40v at 30 amperes for motive charging.

Circle No. 236 on Subscriber Service Card

Portable Ultra Clean Room

Space White Industries, a division of Ultrasonic Laboratories, Inc., is marketing an Inflatable Ultra Clean Room, made of nylon impregnated with polyvinyl.

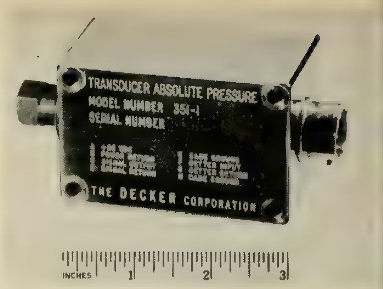
The 15 x 20 x 8-ft. room is supplied with a packaged air conditioner with a capacity to control temperature within one degree. The 3 h.p. air conditioner provides 900 cfm. The pressure that inflates the unit also prevents the entrance of undesirable air-borne particles. For environmental protection, the room is equipped with a Cambridge absolute, inception type filter which has an efficiency of 99.97% of particles 0.3 microns. The room is entered through a 2.5 x 4 x 7 ft. air lock, which is coated with an epoxy urethane primer and two coats of crosslinked polyurethane polyester.

Accessories accompanying the installation are a vacuum cleaning system, a shoe cleaner and a tacky mat.

Circle No. 237 on Subscriber Service Card

Pressure Transducer

A new precision absolute pressure transducer aimed at long-duration aerospace applications is now available from the Decker Corp., Bala-Cynwyd, Pa. Five versions of the device, with pressure ranges from 0 to 0.1, 0.5, 1.0, 2.5, and 5.0 psia, are available. The highly sensitive unit, is designed around Decker's capacitance-type T-42 ionization transducer used in conjunction with a flat-stretched, pressure-sensitive metal diaphragm. A pressure change of 0.02% of full scale will cause an equivalent voltage change. Using a small built-in vacuum chamber as a reference, the motion of the diaphragm from applied pressure to be measured is sensed by the T-42 and converted into analogous dc output signals. Response time from 0.5v dc to 4.5v dc is 15 ms or less, according to Decker. The firm reports the device weighs less than 20 oz., and exhibits a high degree of repeatability (0.01% deviation of full scale). Hysteresis effect is negligible, said to be less than 0.01%. Leak detector checks show a leak rate of 1 x 10^{-14} std cc/sec. The firm says the unit has been selected for use aboard *Centaur, Thor, X-15, X-20,* Project *ASSET* and various ARC sounding rocket probes.



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Load Cells

A series of water cooled load cells has been developed by Lebow Associates, Inc., for operation at temperatures up to 500°F. The cells can be used in a vacuum.

Water cooling maintains the temperature of the unit below 175°F, eliminating the effect of high temperatures on zero, creep and output.

Capacities range from 25 to 1,000 lbs. The cells are usable in both compression and tension.

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Angular Indexing System

Available from Razdow Laboratories, Inc., is a combination mechanical indexing head and electro-optical vernier control that boasts a 0.1 arc-second repeatability and 0.3 arc-second absolute accuracy.

The Ultradex table generates angles from 0 to 360 degress in one degree increments with an absolute accuracy of 0.25 second of arc. Parallelism and concentricity of table are held to 50 millionths of an inch.

The Midarm optical unit monitors the table movement as a vernier and its electrical output drives a remote numerical counter to display the angle with eight-digit resolution so that information is available automatically and continuously.

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Space contributed as a public service by this magazine.

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The infant field of aerospace coatings is receiving intensified consideration at IITRI and promises an attractive future for an aggressive, self-starter who would like to blend laboratory and promotional work at the project leader's level. The man selected for this demanding new work should be interested in the application of physico-chemical principles to the general area of non-metallic coatings research.

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names in the news

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R. A. Correa: Elected a corporate vice president of American Machine & Foundry Co., New York City.

Walter J. Rooney: Appointed vice president and general manager of Belmont Packing and Rubber Co., Philadelphia.

Capt. William Dubyk (USN Ret.): Appointed director of manufacturing at Avco Corp.'s Ordnance Div., Richmond, Ind.

George C. Perris: Named merchandising manager of semiconductor products at International Telephone and Telegraph Corp., Lodi, N.J.

William S. Hepner, Jr.: Appointed director of public relations at Electronic Industries Assn., Washington, D.C.

Joseph Hughes: Appointed controller of the MGM Div. of Thompson Ramo Wooldridge Electronics, El Segundo, Calif.

James I. Leabman: Appointed vice president-marketing of Navigation Computer Corp., Norristown, Pa.

Col. Albert J. Wetzel: Former Assistant for Policy to the Deputy Chief of Staff for Systems and Logistics, named executive secretary to the Air Council, U.S. Air Force Headquarters.

Shirley D. Brinsfield: Appointed general manager of the Electronics Div. of Curtiss-Wright Corp., East Paterson, N.J.

J. Alfred Earl: Appointed vice president in charge of research and development at Physical Sciences Corp., Arcadia, Calif.

Joseph F. Clayton: Appointed director of planning at Bendix Corp.'s Systems Div., Ann Arbor, Mich.

Dr. Thomas F. Hart: Appointed manager of marketing, Silicones Div., Union Carbide Corp., New York City.

Byron G. MacNabb: Appointed director of test engineering for General Dynamics/Astronautics, San Diego, Calif. **Ken E. Newton** named director of Atlantic Missile Range operations, and **Don L. Fagan** named director of operations at Vandenberg AFB.

Clarence W. Patterson: Joined Space and Systems Div. of Packard Bell Electronics as manager, Washington, D.C., office.

Earle M. Knibiehly: Named director of research and development for Log-Etronics, Inc., Alexandria, Va.

Fred Bucy: Elected vice president in charge of the Apparatus Div. of Texas Instruments, Inc., Dallas. **H. J. Wissemann,** vice president, named manager of the corporate research and engineering activity. **Dr. Ross Macdonald** appointed director of the Central Research Laboratories. **Edward Hill** appointed manager of the industrial products group in Houston.

Dr. Gustav H. Strohmeier: Appointed a vice president of ITT Research Institute, Chicago.

Arnold Lurie: Joined Electro-Optical Systems, Inc., Pasadena, Calif., as a manufacturing engineer in the Electronic Fabrication Dept. **Arthur M. Schneider** appointed a senior engineer in the Fluid Physics Div.

Alexander Alexandrovich: Appointed assistant to the vice president for engineering technology at Grumman Aircraft Engineering Corp.'s Ordnance Dept., Bethpage, L.I., N.Y.

Dr. Herbert I. Fusfeld: Named director of research of Kennecott Copper Corp., New York City.

Harry J. Schmidt: Appointed a program manager for packaged liquid engine production at Thiokol Chemical Corp.'s Reaction Motors Div., Denville, N.J. **Donald Zimmet** appointed program manager for the *Surveyor* engine program.

Kenneth A. Bacon: Appointed electromechanical component marketing manager at United Aircraft Corp.'s Norden Div., Norwalk, Conn.

Dr. Herman I. Leon: Appointed director of Systems Research and Technology Center, San Fernando, Calif.

Richard S. Johnston: Named chief of the Manned Spacecraft Center's Crew Systems Div., Houston.

—when and where

SEPTEMBER

IRE National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., Sept. 9-11.

18th Annual Instrument-Automation Conference and Exhibit, sponsored by the Instrument Society of America, McCormick Place, Chicago, Sept. 9-12.

National Symposium on Space Rendezvous, Rescue and Recovery, sponsored by American Astronautical Society and Air Force Flight Test Center, Edwards Air Force Base, Calif., Sept. 10-12.

17th Annual National Convention and Aerospace Panorama, Air Force Assn., Sheraton-Park and Shoreham Hotels, Washington, D.C., Sept. 11-15.

Institute of the Aerospace Sciences, Antisubmarine Warfare Meeting, San Diego, Calif., Sept. 16-18.

American University, Institute of Electronic Informations Display Systems, International Inn, Washington, D.C., Sept. 16-20.

Industrial Electronics Conference, sponsored by AIEE, IRE and ISA, Michigan State University, East Lansing, Mich., Sept. 18-19.

IEEE Annual Conference on Communications, Cedar Rapids Section, Hotel Roosevelt, Cedar Rapids, Iowa, Sept. 20-21.

National Power Conference, sponsored by ASME, AIEE and IRE, Netherlands-Hilton Hotel, Cincinnati, Sept. 22-25.

International Telemetering Conference, Hilton Hotel, London, Sept. 23-27.

Aeroelastic and Dynamic Modeling Technology Symposium, sponsored by AF Systems Command's Aeronautical Systems Div. and the AIA, Biltmore-Hilton Hotel, Dayton, Ohio, Sept. 23-25.

Recently Acquired Knowledge of the Space Environment Meeting, sponsored by the XIVth International Astronautical Congress and the International Astronautical Federation with the cooperation of UNESCO and COSPAR, UNESCO House, Paris, Sept. 27.

IRE Canadian Electronics Conference, Toronto, Can., Sept. 30-Oct. 2.

AIAA Meeting on Engineering Problems of Manned Interplanetary Exploration, Cabana Motor Hotel, Palo Alto, Calif., Sept. 30-Oct. 1.

OCTOBER

AIEE Fall General Meeting, Pick-Congress Hotel, Chicago, Oct. 6-11.

IRE National Communications Symposium, Utica, N.Y., Oct. 7-9.

U.S. Air Force Interceptor Weapons Meeting, hosted by the Air Defense Command, Tyndall Air Force Base, Florida, Oct. 7-14.

Corrosion of Military Equipment Committee, National Assn. of Corrosion Engineers, Admiral Semmes Hotel, Mobile, Ala., Oct. 8-9.

Aerospace Electrical Society, Aerospace Electronic Exposition, Pan Pacific Auditorium, Los Angeles, Oct. 9-11.

Materials Handling Conference, sponsored by ASME, AIEE and IRE, Chamberlain Hotel, Newport News, Va., Oct. 14-15.

Users of Automatic Information Display Equipment Annual Meeting, Carillon Hotel, Miami Beach, Oct. 15-17.

AIAA/CASI, RAeS Ninth Anglo-American Conference, Massachusetts Institute of Technology, Cambridge, Oct. 16-18.

American Vacuum Society, National Symposium on Vacuum Technology, Statler-Hilton Hotel, Boston, Mass., Oct. 16-18.

Tenth East Coast Conference on Aerospace and Navigational Electronics, Emerson Hotel, Baltimore, Md., Oct. 21-23.

American Society for Metals, Annual Meeting and National Metals/Materials Show and Exposition, Public Auditorium, Cleveland, Oct. 21-25.

Ninth Conference on the Design of Experiments in Army Research, Development and Testing, Redstone Arsenal, Huntsville, Ala., Oct. 23-25 (by invitation only).

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editorial . . .

Lessons from the Hill

NOW THAT CONGRESS has passed the National Aeronautics and Space Administration authorization bill for Fiscal 1964, there are some lessons to be learned from its obstacle course on the Hill.

Chief among these is the fact that the glamour of the space program is no longer enough to carry the agency's funding requests smoothly through Congressional hearings. NASA representatives from Administrator James Webb down took a real battering in both House and Senate space committees. Detailed questioning covered not only aspects of major programs such as *Gemini* and *Apollo* but also such subjects as bridges, highways, heliports and landing strips.

Space agency spokesmen found themselves forced to justify dollar after dollar for even small items. Testimony at times got into such detail as the parts per million of magnesium in the potable water supply for the Mississippi Test Facility.

This is the third successive budget in which the Kennedy Administration has pressed for substantial increases to support the major space effort in which this country is engaged.

With each budget, the course has grown more difficult. This is most dramatically shown by the narrow margin by which the final compromise bill escaped a last-minute effort to slice NASA funds still further.

Just before the final vote approving the bill, a motion to recommit the bill to conference with instructions to House negotiators to take an unyielding stand on House budget cuts was rejected by a vote of only 200-176.

The bill sent to President Kennedy authorizes some $350 million less than requested by the space agency—not a disastrous cut in terms of dollars, although the reduction could have been more judiciously applied in some areas. But warning signs are up that budget troubles for the space agency are not yet over.

Appropriations committees of the Congress still must complete action on the NASA budget. Further reductions in funding are likely.

The House and Senate conferees also approved new rules which will closely restrict NASA's reprograming authority. This means Congress will not abandon its watchdog role once the money bills are passed. It will be keeping a close eye on NASA activities throughout the fiscal year.

This is right and proper, but NASA will have to do its program planning with this closer scrutiny in mind if the Fiscal '65 budget is to escape an even greater pruning. To keep the *Apollo* and *Gemini* projects moving ahead on schedule, the space agency will have to show willingness to forego some of its other pet projects. Some purely scientific exploration may have to take a back seat to the lunar program.

There still is the question of that electronics research center which the space agency wants to plant in Boston. Congress wisely has asked NASA to come back with further justification both for the center and its location. This is sound—nothing the space agency has submitted to Congress as yet builds a complete case for the center. Without doubt, it is desirable. But whether it actually is necessary is another question.

The timetable for the center makes it clear that it would not contribute greatly to Project *Apollo;* this must be a consideration in justification of the center. Primary task of the space agency at this time is successful conclusion of the lunar mission—all else must give way to the demands of that program.

LOOKING BEYOND the budget problems of NASA alone, there are some clear Congressional lessons for the Administration in its overall approach to space in both civilian and military programs.

Many Congressmen plainly are impatient over the fact that so little attention is being devoted to military space activities. A stronger military tinge to the Administration's financial requests in the space field would do much to assure a smoother passage for the FY '65 budget now being whipped into shape.

Just as some NASA developments are cited as possible areas of technological fallout for the military, there are areas where military space projects could provide valuable technology for the space agency.

Even a layman can observe the similarity of shapes between the *M-2* wooden glider which NASA is towing around the Mojave desert and the Air Force's *Dyna-Soar* project. We suggest that this area of lifting bodies and of ferry vehicles for space stations is one which the Administration—and NASA—could well leave to the military.

Another is the *National Orbiting Space Station.* Chances for funding of this in the 1965 budget are slim. But if it is to survive at all—and the Air Force regards it as a vital project—it will survive as a military program. NASA certainly should not seek to take on this project at the possible expense of diverting funds and technical manpower from *Apollo.*

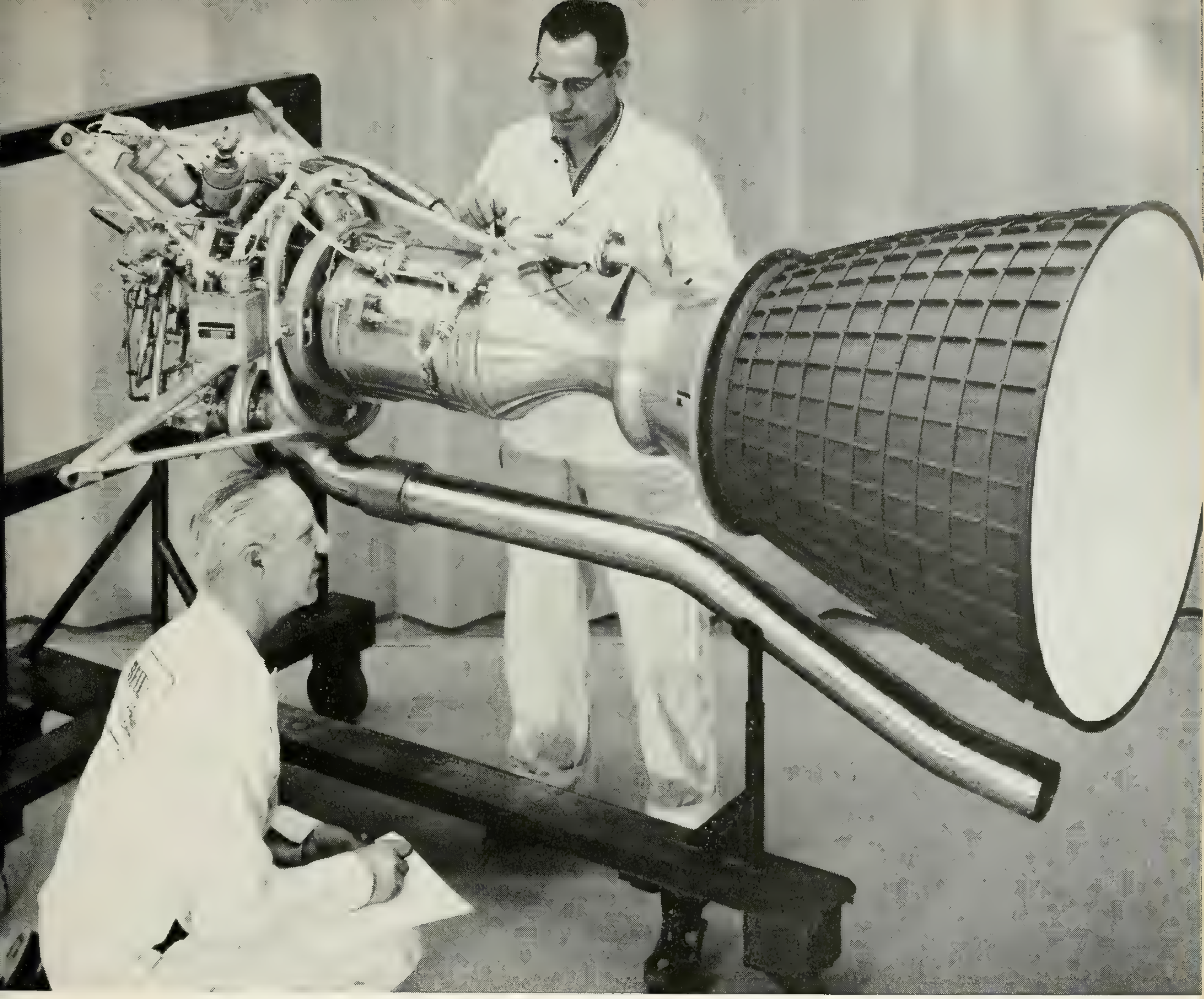
The space agency should, in the national interest, support Air Force ambitions in these two areas. The space agency stands to gain in the long run if *X-20* and *NOSS* can be pushed along at a faster rate than the NASA budget would provide.

While it is not likely that an $8-billion budget for the space agency would get through Congress without a severe shearing, it is quite probable that a $6-billion request for NASA and a $3.5-billion request for military space would meet smoother sailing.

We regard development of *NOSS* and *X-20,* together with an expanded Air Force partnership in *Gemini,* as vital to the military security of this nation. The Administration not only should recognize this, it should acknowledge that inclusion of these programs in a military, rather than civilian, budget is the most expedient route to passage on the Hill.

In turn, Congress must be prepared to acknowledge that, as Brainerd Holmes pointed out, the major funding for *Apollo* is coming now and in the Fiscal 1965 budget—not in the months just before the first American steps on lunar soil.

William J. Coughlin



Bell Aerosystems' powerful Agena engine has an uncooled Rokide ceramic-coated titanium nozzle extension.

Titanium's compatibility with ceramics makes rugged, light-weight parts for ultra-high temperatures

One of the first practical examples of a unique partnership is now hard at work in space: the Agena's ceramic-coated titanium rocket nozzle extension.

Alone among structural materials, titanium has a coefficient of expansion (5.7×10^{-6} in./in./°F) close to vitreous materials. This useful compatibility opens up many possibilities for tough, strong parts that can be subjected to ultra-high temperatures. Where before only unsupported graphite and ceramics could withstand the searing blast of rocket gases, re-entry and the like, it is now possible to mate ceramics to titanium. Results...?

Take a look at the uncooled nozzle extension on the Agena. According to Bell Aerosystems Company, who designed and built the Agena engine, a base of titanium sheet coated with aluminum oxide was able to save 20 pounds over the original unsupported graphite part. Yet it was able to give equal heat resistance and at the same time provide a significant increase in strength and ability to withstand rough handling.

The uncooled titanium-ceramic nozzle extension has increased nozzle area more than 100% over the previous model, contributing to an improvement in specific impulse and superior performance. The restartable Agena engine has become the workhorse of the Air Force's Satellite Program, the Ranger, Mariner and other NASA programs.

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Polaris:
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Polaris has done a lot of growing since January, 1957, when the U. S. Navy first announced its plans for a ballistic missile to be launched from submerged submarines. The original A-1 has a range of 1200 miles. The A-3, now in flight test at Cape Canaveral, has a range of 2500 miles.

The 144 Polaris missiles now on patrol are the mainstay of the nation's deterrent force. The Navy plans a total of 41 Polaris submarines, each carrying 16 missiles it can launch from the depths in as many minutes.

Polaris is a versatile missile. Compact, easy to transport, and extremely reliable, it can be launched from surface ships—or, by remote control, could be launched from the floor of the sea. Today the Navy-Lockheed team is prepared to meet whatever new challenges lie ahead for Polaris.

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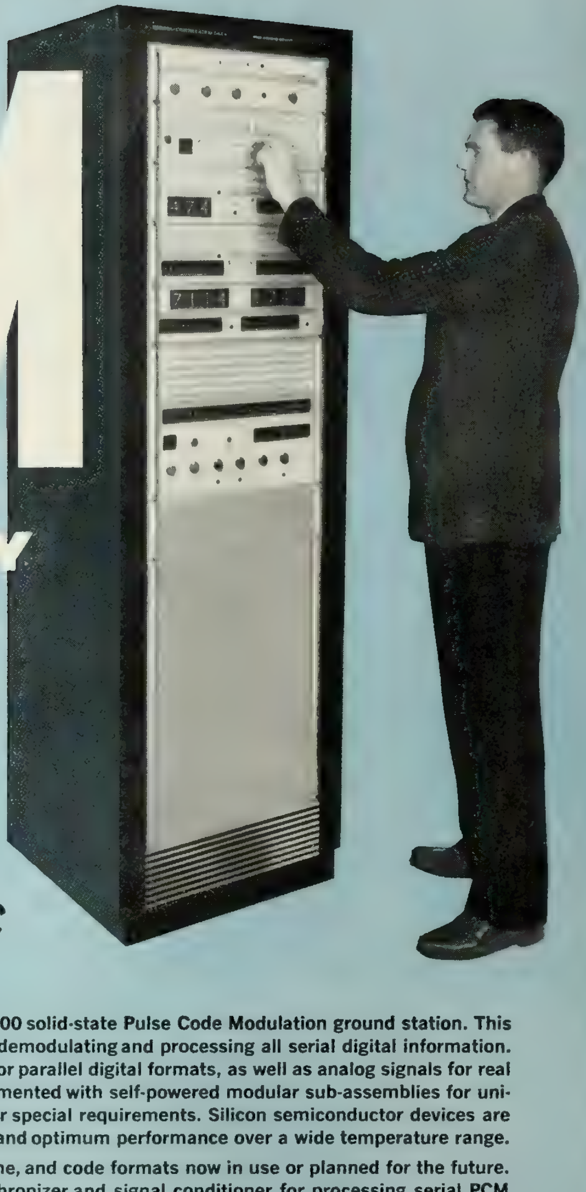

The latest from Bendix-Pacific—Model DDS-1000 solid-state Pulse Code Modulation ground station. This is a digital decommutation station capable of demodulating and processing all serial digital information. Outputs are available in a wide variety of serial or parallel digital formats, as well as analog signals for real time visual analysis of data. Flexibility is implemented with self-powered modular sub-assemblies for universal applications, as well as mechanization for special requirements. Silicon semiconductor devices are used throughout the system for high reliability and optimum performance over a wide temperature range.

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Model DDS-1000 is a development of Correlated Data Systems Corporation and available exclusively from Bendix-Pacific. Contact Bendix-Pacific, North Hollywood, for complete information.

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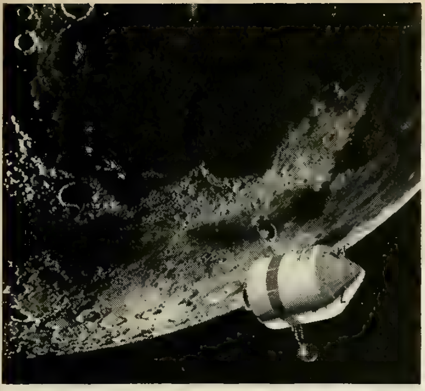

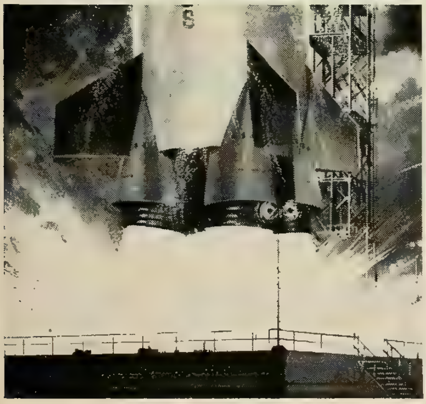

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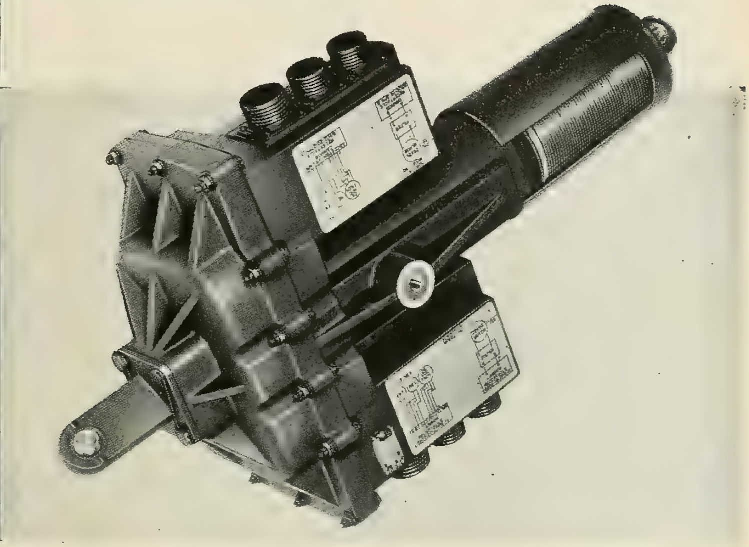

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Steering a proper course to the moon, establishing a vehicle in lunar orbit and then ejecting it again to return to earth requires precise control of the engine gimbals. For this and other vital functions, the Power Equipment Division of LSi designs and builds servo actuators which combine fast response, long shelf life and unusually long MTBF. Each Apollo actuator utilizes redundant power trains with proven DC motors, stationary coil dry particle magnetic clutches and a common ball bearing screw assembly. The entire unit is hermetically sealed using special static and dynamic techniques. LSi actuators of this type have been used successfully on many missiles, torpedoes and manned aircraft now in operational use. If your requirements involve precision actuation, why not consult Power Equipment Division first?

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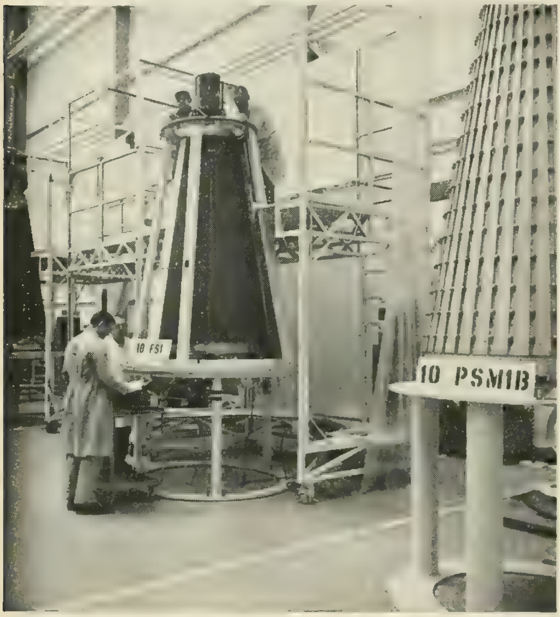


Fabrication of SNAP 10A systems at A.I.

Atomics International is a prime contractor for SNAP nuclear reactor systems for the U.S. Atomic Energy Commission. Responsibilities of the company include the entire SNAP 10A and SNAP 2 systems, as well as the reactor for SNAP 8. These power sources are designed to generate from 500 to 35,000 watts of electricity for a one-year period of unattended operation in space. Already several A.I. SNAP reactors have successfully passed their initial ground operating tests.

For the National Aeronautics and Space Administration, A.I. is studying the uses of compact nuclear power sources on the moon. To be determined: what design modifications would fit SNAP 2 and SNAP 10A for powering instruments and communications equipment on the lunar surface? Also, how could SNAP 8 be adapted to the power needs of a manned lunar base? SNAP applications might include lunar communications stations capable of operating for long periods unattended... perhaps a manned lunar experimental laboratory or astronomical observatory.

If you are interested in these and other rewarding challenges of space, the time for action is now. Opportunities now available in Atomics International's SNAP programs and other advanced nuclear work include the following:

SYSTEMS & CONTROL ANALYSIS — Analysis and simulation of complete nuclear power plants to develop reliable, automatic control and instrument systems to analyze reactor kinetics, dynamics, stability, thermal characteristics and reliability.

STRESS ANALYSIS — Provide stress analysis of compact nuclear power plants for space applications including review of all designs with respect to stresses resulting from thermogradients; transients, static loadings, vibrational and shock loadings.

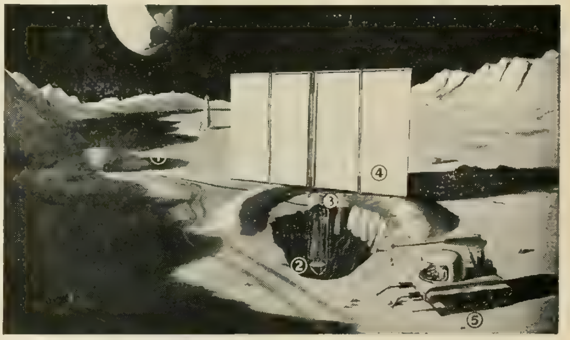
COMPONENT TESTING — Analysis of liquid metal heat transfer components in the SNAP 2/10A systems. Calculations involve knowledge of fluid flow, heat transfer, stress analysis and basic electrical engineering.

ENVIRONMENTAL TESTING — Plan and provide instrumentation for environmental tests of SNAP components and systems primarily for shock, vibration, acceleration, static loading and acoustics.

STRUCTURES — Analyze, investigate and physically test SNAP 2 radiator condensers and test fixtures to determine structural characteristics for launch loads, aerodynamic heating, shock and vibration.

DESIGN — Design high temperature, high reliability nuclear reactor auxiliary systems. Skills required in mechanical design, stress analysis and heat transfer.

Contact: Mr. H. J. Newton
Personnel Office, Atomics International
8900 De Soto Ave.
Canoga Park, California



Manned moon base illustrated at (1) would receive its power from SNAP reactor (2) beneath lunar surface. (3) shows power conversion units; (4) is radiator to dispose of excess heat. Roving electrical vehicle (5) would use SNAP power to charge its batteries.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 12 September 16, 1963

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THE COVER

Scout launcher is shown lifting the rocket from its truck cradle at Ling-Temco-Vought's Chance Vought Astronautics Div., Dallas. The launcher will soon go to work at NASA's Wallops Island facility, increasing the center's potential launch rate. See page 41.

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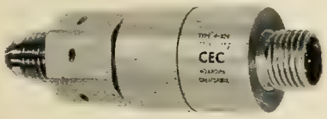

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letters

Holmes' Resignation

To the Editor:

One of your readers referred to Brainerd Holmes in a letter as a spoiled little girl who refused to play because she could not have her way.

It is my opinion that Mr. Holmes knew what ought to be done, and he could not reconcile it with what he was told to do. I imagine he must have been disheartened that we can somehow provide funds, and huge ones, to support paper empires, but we cannot find the money to do a highly technical job the right way.

I believe that he must have wondered why it is that we have the funds to pay people who actually sabotage our best scientific and technical efforts with their mediocrity, their unwillingness to study a problem, and their talents for office intrigue.

Mr. Holmes wears, in my opinion, a "white badge of courage," an injury inflicted upon him by the octopus-like, paper-pushing empire of non-technical men. I am glad he refused to compromise.

We need more men of Mr. Holmes' type, and fewer of the men who parasitically suck our tax funds. The latter, I think, are the real "ugly Americans."

Tony Berger
Burbank, Calif.

Anticipating Tomorrow

To the Editor:

The people at the Arnold Engineering Development Center thoroughly enjoyed your editorial "A Need to Know" in the Sept. 2 issue. General Schriever's statements reflect the critical value of R&D laboratories adequate for supporting future development. My previous experience as deputy commander at the Cape is the basis for a particular appreciation of the work that can be done in laboratories such as these at AEDC.

You are correct in your statement that these facilities, originally conceived and designed in the 1950's, are an important means to solve current development problems. This capability, however, is the result of an aggressive movement and modification program that has been underway here for many years.

We have an extremely flexible system for providing large volume air supply for handling exhaust products and for cooling, heating and otherwise conditioning the environments in which the hardware is tested. The AEDC people have made optimum use for applying these facilities to new testing tasks. This job of extending our capabilities is continuing.

William L. Rogers
Major General, USAF
Commander
Arnold Engineering Development Center

Pride and Prestige

To the Editor:

I have passively read your publication for some time—in fact, I am one of your charter subscribers—and during this interim have remained sufficiently detached to have never written you before. But there is a first for everything, and this one is motivated by your Aug. 19 editorial, "The Moonbeam Business."

My comments do not center about Senator Clark's proposal to match Soviet funds in a joint venture to reach the Moon. This, idealistically, is not as absurd as your vitriolic words make it seem. However, I will grant that realistically—and I refer to the record of Soviet past performance—it is as highly debatable an enterprise as the signing of a nuclear test ban treaty. What I seriously object to is your sarcastic belittling of the Senator in reference to his comments about the Moon project in general. His questioning the wisdom of the enterprise as a "race" justified in terms of national "pride" or "prestige" is not unreasonable. His suggestion that we are "acting like the whole thing is a college football game or perhaps a high-school cross-country race," though quaint, is certainly undeserving of your sharp reply. Do not discount the fact that the overwhelming expenditures of our government in pursuing "the moonbeam business" are highly in question by many public figures, not only this unknown correspondent. The imbalance between current NASA and DOD budgets is startling to many. To justify this imbalance in terms of "pride" and "prestige" is, to say the least, less than adult. The justification cannot be founded on military value, for the tactical advantage of the Moon is nil. It could, conceivably, be based on the concept of man's natural curiosity and his never-ending desire to probe new scientific frontiers. But to base it on "pride" and "prestige" is childish and may even prove to be disquieting to many who remember what it says in Proverbs, XVI, 18:

"Pride goeth before destruction, and a haughty spirit before a fall."

You may borrow from the NASA reply to Sir Bernard Lovell and interpret what I say as "the personal impressions of a private individual on a matter of the greatest obscurity." In fact, you may even relegate me to the same obscurity to which you so unkindly retire Senator Clark in the closing sentence of your editorial. Neither will matter. However, I do feel that your open apology to Senator Clark over your childish reprimand of his adult observation will prove to many of your readers that you are both a gentleman and an emotionally mature person.

Charles J. Rodriguez
Woodland Hills, Calif.

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The Countdown

WASHINGTON

Security Hides Proof of Soviet ABM Lead

Only the limitations of security classification prevent the presentation of more specific proof of the obvious Soviet lead in technology in the anti-ballistic missile (ABM) field, Sen. Strom Thurmond (D-S.C.) told the Senate last week in the debate on the nuclear test ban treaty.

Funding of Aerospace Plane Is Cut

Dept. of Defense has cut Fiscal 1964 funding for Air Force's *Aerospace Plane* program from $19 million to $6.5 million. DOD says the action was taken because of the recent House reduction in the military budget. It has not, however, appealed to the Senate to restore funds for the program. Hardest hit: propulsion research.

Explorer IV Transmission Falters

Explorer IV micrometeoroid detector satellite has stopped transmitting usable data after about seven months in orbit. The data received thus far is inconclusive and NASA says more satellites will have to be launched before the meteoroid hazard can be clearly defined.

Slippage of Apollo Shot Is Official

NASA officials now admit that the first manned Earth orbital flight of the *Apollo* spacecraft is slipping six to nine months. But they claim it will not affect the manned lunar landing flight schedule. First U.S. attempt to land a man on the Moon still is scheduled for October or November, 1968. Slippage into 1969 or 1970 is very possible. The *Saturn V* booster is said to be the pacing item. If it meets its late 1966/early 1967 launch date, the manned lunar landing could still be made before the end of the decade.

Passive Comsats Get Boost

Passive communications satellites are receiving new life as a result of the U.S.-Soviet Union agreement on space cooperation, which calls for joint experiments with the *Echo II* satellite. Earlier, NASA indicated it was reducing funding in the program and the advanced *Project Rebound* passive Comsat was killed completely. Now the space agency is anticipating further experiments with the Russians using passive Comsats. Serious consideration is being given to a huge 450-ft. diameter version of *Echo*.

Airborne Post to Command Missiles

Dept. of Defense is still developing a system for firing of advanced U.S. missiles by a signal from an airborne command post. Use of the aircraft would eliminate the requirement for survival of launch control centers and their cable connections with the site, research chief Harold Brown told the Senate. He didn't comment on what electromagnetic interference from a nuclear blast could do to such a system.

NASA Re-programs Saturn S-II Funding

NASA has advised Congress of space agency plans to re-program an additional $9 million to modify or add to facilities needed to develop the *Saturn S-II* stage. Funding will be used at three North American Aviation locations: Downey, Santa Susana and Seal Beach, Calif.

AF Denies Space Station Okay Received

Reports that Air Force has received approval from Dept. of Defense to issue RFP's for study contracts for the *National Orbiting Space Station (NOSS)* have been denied by the Pentagon. Approval is expected eventually because Kennedy Administration officials want some idea of AF requirements before deciding whether AF or NASA should manage the project.

INDUSTRY

HIBEX Contract Goes to Boeing Co.

Studies of guidance and detection aspects associated with HIBEX (high-impulse booster experiments) now are under way. First testing of the 30-ft. booster is expected within a year. Contract was awarded last week to Boeing Co. for development of the booster in the search for a more effective anti-ballistic missile system.

Aerojet SNAP-8 Unit Is Funded

Aerojet-General has received more than $48 million to begin hardware development of the *SNAP-8* nuclear electric power unit. Two complete prototype flight systems will be delivered in 1967 for simulated flight testing at the Lewis Research Center of NASA. Each of the 35 kw units will weigh between 4,200 and 4,500 lbs. and will have shielding weighing between 1,000 and 1,500 lbs. for various manned and unmanned missions.

Grissom Says Misquoted on Titan

Astronaut Virgil "Gus" Grissom told Martin Co. Baltimore division employees recently that he was misquoted by a national magazine which attributed to him a statement that "*Titan* is no-go." He said, "I am here to declare that *Titan* is go. As far as I am concerned, we are very pleased by the way *Titan* has turned out."

USAF May Buy Paraglider Space Trainers

Paraglider flight trainers may be purchased or built by the Aerospace Research Pilot School at Edwards AFB, Calif., to introduce potential Air Force astronauts to the characteristics of paraglider recovery systems. The school is interested in the cost advantages of teaching just one space flight task at a time. NASA astronauts will use the North American towed test vehicle paraglider in the same role when it has served its purpose in Project *Apollo*.

Curtiss-Wright Interested in Garrett Shares

Curtiss-Wright Corp. has announced an offer to purchase 700,000 shares of the common stock of Garrett Corp. at a net price of $50 per share payable in cash. A Curtiss-Wright spokesman says a principal reason for the offer is his company's convictions that the purchase is a sound investment in an established aerospace firm.

INTERNATIONAL

French Planning Polar Comsat System

France is considering development of a low-cost communications satellite telephone network which would link Europe, the Far East and the U.S. with a series of satellites in polar orbit. French are interested in establishing such a link in cooperation with the U.S. Communications Satellite Corp. while avoiding American domination of the system.

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The Missile/Space Week

New Life for MMRBM?

Department of Defense will begin Phase II development of the *Mobile Medium Range Ballistic Missile (MMRBM)* if the $100-million cut from the program by the House is restored by the Senate and survives conference action.

Secretary of Defense Robert McNamara said that the decision not to go ahead with the program was due solely to the cut, and that development would begin if the full amount were provided. There was some question as to DOD's intentions about the program when the Secretary did not request restoration of the $100 million. However, the Joint Chiefs of Staff appeared before the Senate Defense Appropriations Subcommittee in an unprecedented action to go against their chief and ask for the money.

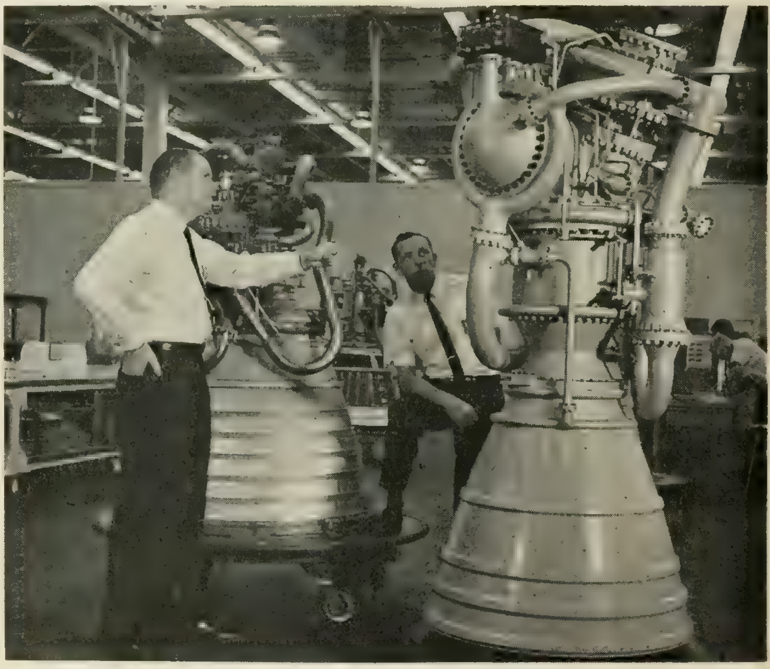
Sen. Carl Hayden (D-Ariz.), chairman of the Appropriations Committee, said he would offer an amendment to the bill providing for restoration of *MMRBM* funds. McNamara's views were contained in a letter written in answer to one by Sen. Hayden.

Holmes Receives Award

The space agency has presented D. Brainerd Holmes, the former director of its manned space flight program, with the NASA Medal for Outstanding Leadership.

James E. Webb, NASA Administrator, made the presentation to Holmes Sept. 5 at a ceremony in NASA Headquarters.

Webb pointed out that Holmes had carried for two years management responsibility for the nation's manned lunar landing program working through NASA's technical organ-



Pratt & Whitney Unveils H_2 Engine Mockup

PRATT & WHITNEY engineers inspect a full-scale mockup of the firm's high-pressure hydrogen/oxygen engine. The powerplant, a smaller version of which has been tested successfully (M/R, Sept. 9, p. 10), uses a new cooling approach at chamber pressures significantly higher than those of current engines. The method is neither regenerative nor ablative, which leaves transpiration as the normally accepted third technique. AN RL-10 engine stands in the background for comparison purposes.

izations at the Manned Spacecraft Center, the Marshall Space Flight Center and the Launch Operations Center. Also, included within his manned flight responsibilities was direction of the final phases of the *Mercury* program and organization of a program of two-man extended flight in Project *Gemini*.

Lockheed Execs Shifted

Lockheed Aircraft Corp. has named M. Carl Haddon to replace Willis M. Hawkins in that firm's top scientific and engineering post.

Hawkins vacated the position of vice president-science and engineering to accept a Presidential appointment as assistant secretary of the Army for research and development. Herbert Caldwell was promoted to Haddon's former job as president of the Lockheed-California Co.

The vice presidency of science and engineering is a policy-determining position charged with guiding the corporation's scientific and technical work in missiles, satellites, spacecraft, electronics, propulsion, aircraft, nucleonics and oceanography.

Saturn VAB Bids to Open

The Corps of Engineers' Canaveral District will open bids Nov. 19 in Jacksonville, Fla., for construction of the *Saturn V* Vertical Assembly Building (VAB) on Merritt Island.

VAB, the world's largest building, is being erected as part of Complex 39 where the nation's manned lunar shots will originate.

The Engineers estimate the VAB construction will run about $55 million, more than double the next largest contract let for space-age construction in the area. Contracts already let for the foundation, dredging, design and steel framework will run total cost of the building near the $95 million mark.

Shots of the Week

NASA launched an *Aerobee* rocket from its Wallops Island, Va., launch site Sept. 11 in an experiment to study behavior of liquid hydrogen exposed to radiant heating and zero-gravity conditions.

The rocket reached 102 miles, and the 247-lb. payload was suspended in a state of weightlessness for some 5 minutes. Telemetry data received was described as "excellent." Payload recovery was not planned.

Other shots of the week:

The Air Force launched two rockets on Sept. 6. One, an *Atlas-Agena*,

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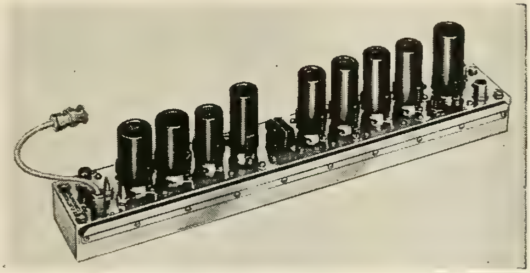

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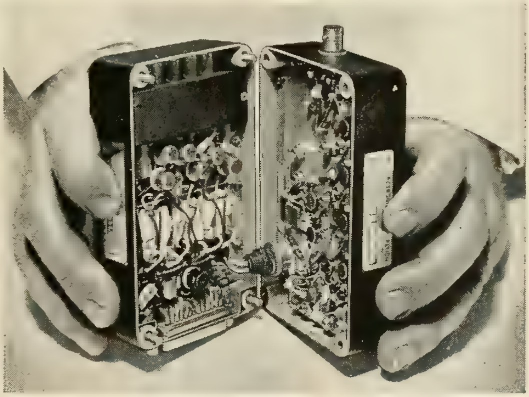

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was launched from Point Arguello, Calif. Its payload was not disclosed. The second was an *Atlas* ICBM, launched from Vandenberg AFB, Calif., by a Strategic Air Command crew on a training mission.

NASA fired a *Nike-Apache* rocket from Wallops Island, Va., on Sept. 9 in preparation for a series to be conducted in India late this year. The rocket carried a 70-lb payload containing instruments to measure the altitude and intensity of electric current systems in the ionosphere.

Guidance Proposals Asked

Twenty-two firms have been asked to submit proposals to conduct a program definition study on the Air Force's next-generation standardized space guidance system (M/R, Sept. 9, p. 16).

Receiving requests for proposals from the Air Force Systems Command's Space Systems Division were: American Bosch Arma, Autonetics, Bell Aerosystems, Bendix, General Electric, General Motors, General Precision, Goodyear Aircraft, Hughes Aircraft, IBM Federal Systems, Litton Industries and Minneapolis-Honeywell Regulator.

Also: Northrup, Philco, Raytheon, Space Technology Laboratories, United Aircraft Corporate Systems Center, Westinghouse Electric, Burroughs, Western Electric, Sperry Rand, and Ling Tempco Vought.

J-2 Test Stand Readied

A 183-foot tall double test stand for 200,000-pound thrust J-2 engines will be placed in operation at Canoga Park, Calif., early in October by the Rocketdyne Division of North American Aviation, Inc.

Test runs of more than 500 seconds are planned for the J-2 engines, which will power upper stages of the *Saturn I-B* and the *Saturn V*.

The stand includes a 90,000-gallon tank for liquid hydrogen and two 28,000-gallon liquid oxygen tanks.

One of the two engine test positions will eventually be modified to permit engine test runs in a near-vacuum, simulating 60,000-foot altitude.

French Satellite Prepared

France has announced plans to launch its first satellite, the *SATMOS*, next year, using a four-stage *Bérénice* rocket.

The four-pound "pocket satellite" will carry a small radio transmitter and scientific instruments. Mission is to provide data on atmosphere reentry.

Space Surveillance Urged

Chairman of the House Republican Task Force on Space and Aeronautics Rep. Charles S. Gubser (R-Calif.) has urged increased use of satellite surveillance to keep the U.S. posted on Soviet military activity.

"It seems fairly obvious that the nuclear test ban treaty will be ratified by the Senate," he said, and it therefore remains for the Administration to insure that the U.S. "will be forewarned of any Russian intention to break the treaty. The best method of observation today is satellite surveillance."

'Sterilizable' Hardware Sought

NASA has begun a program to develop components that will be able to withstand high temperature heat sterilization.

The space agency disclosed the new program as it announced that it is dropping terminal sterilization of lunar and planetary orbiter spacecraft, but will continue the process for planetary landers. Originally, NASA procedures called for terminal sterilization of all lunar and planetary spacecraft.

The new system was established, the space agency said, after experience with the *Ranger* program proved that reliable sterilized spacecraft could not be built and launched under the present state of the art.

Among the components found vulnerable to heat were television tubes, solid propellant for rocket motors and certain crystals in timers, instruments and radios.

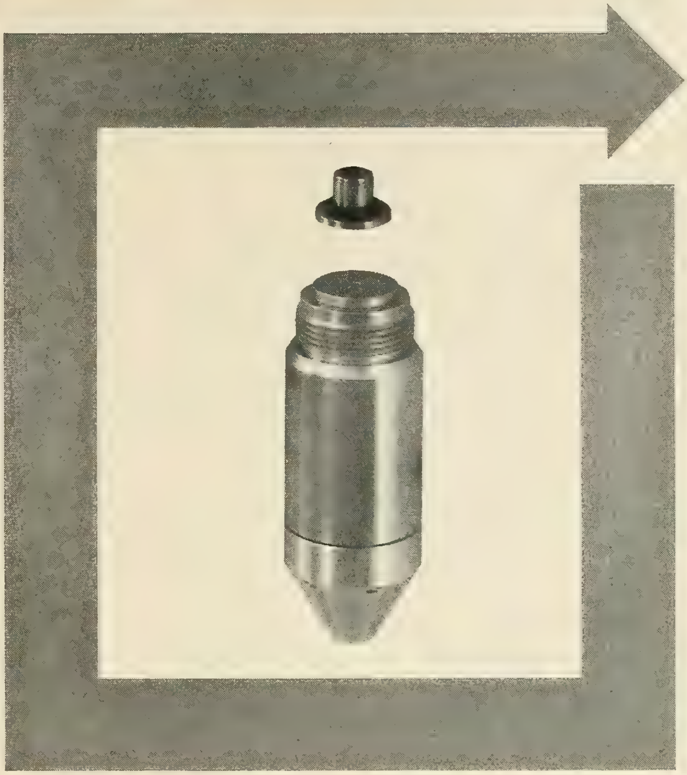
The space agency said that because many state-of-the-art components are downgraded by heat sterilization requirements, a program is underway to develop components that will be able to withstand the high temperatures required.

The immediate objective is to have "sterilizable" components for the capsules to be launched to Mars in 1966.

Efforts are also being initiated to develop a full complement of such parts needed for later missions when entire spacecraft will be landed on the planets.

The program also calls for studies to discover less destructive methods of sterilization.

The program is being set up by a NASA group, chaired by James R. Miles of Lunar and Planetary Programs, to advise in this effort.

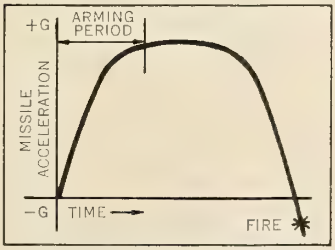


Keeps missiles from going off half-cocked

You'll **never** have to scrub a firing because of this safe/arm device—it's too simple to cause you any trouble! No wires, no power supply, no connectors, no cocked springs, and best of all, no susceptibility to RFI. You can kick it, cook it, magnetize it, and irradiate it, and it still won't do a thing until it's ready; when it **is** ready, the system is "go."

The Model 1029 safe/arm unit functions only from the acceleration profile of the bird which carries it, both arming and firing from inertial forces. It can be programmed to fire within a half a "g" of a selected value, and within 0.050 seconds of a required functioning time. It will initiate a percussion cartridge for ignition, stage separation, or destruct functions, or it may be used to operate a switch.

You need provide only about 3 cubic inches of space in the vehicle for the Model 1029, and allow for less than a pound of weight. And because it's all-mechanical, you won't have any problems with wires or insulation. May we give you some more of the details? Send us a note today.



Typical operating parameters: Arming period 2 seconds at 15 g acceleration; firing on reaching −2.5 g, ±0.5 g.

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Intelligence sources say . . .

Soviets May Have Ultimate ABM

Electromagnetic energy from high-yield blast might neutralize U.S. missiles in silos, leaving 'Maginot Line' deterrent

THE SOVIET UNION may be developing an anti-ballistic missile system capable of de-activating U.S. missiles in their silos with the electromagnetic energy from exploding high-yield Soviet nuclear weapons, Missiles and Rockets has learned.

This possibility, supported by U.S. intelligence-gathering on the 1961-62 Soviet high-yield test series, is behind strong opposition by many high military officers and nuclear scientists to the test ban treaty.

The Soviet lead in anti-ballistic missile development has been acknowledged even by Administration supporters in the test-ban debates. It is based on the long-range ability of strong electromagnetic pulses to cripple the electronics system of a missile so that it cannot be fired.

It could mean that the U.S. has invested billions of dollars in a "Maginot Line" of *Atlas*, *Titan* and *Minuteman* missiles that could be rendered useless by the new Soviet development.

• **Polaris safe**—*Polaris* missiles beneath the sea would be relatively immune, as would manned bombers on patrol far from U.S. shores.

This point was made by Dr. Edward Teller when he told the Senate: "By expanding and perfecting the *Polaris* missile system, we could ameliorate the situation."

U.S. knowledge of Soviet developments in this area has been given the highest national security classification and has been discussed only in closed sessions of Senate committees considering the treaty.

U.S. information comes from monitoring satellite, aircraft and other intelligence sources.

Soviet achievement of such a capability could effectively neutralize the major portion of the U.S. deterrent force in its silos, this magazine is told.

This belief is based on the fact that U.S. military strategy relies on second-strike capability, which concedes the first strike to the Soviet Union and bases the U.S. deterrent on the ability to survive the initial attack and still retaliate.

• **No second strike**—Achievement by the Soviets of the capability of using their first strike offensive weapons simultaneously as defensive weapons that would destroy the electronics of U.S. silo-based missiles could wipe out the ability of the U.S. to retaliate.

AFA Opposes Treaty

The Air Force Assn., on the first day of its annual convention last week in Washington, went on record opposing ratification of the test ban treaty.

Stating that the treaty would pose "unacceptable risks to the security of this nation and of the free world," the AFA reflected much of the opposition expressed before recent Senate hearings by Strategic Air Command chief Gen. Thomas S. Power.

The majority of the 400 delegates expressed particular concern over the disagreement of weapons experts as to the magnitude of the risks involved. The 74,000-member body expressed doubt that the possible political gains offered by the treaty would offset its dangers.

Rather than committing the U.S. to what it terms a nuclear stalemate policy and "an open invitation to Soviet aggression on terms which the free world cannot meet and is not prepared to meet," the AFA proposed a return to the "pursuit of nuclear superiority." The Association said that such a superiority, when it belonged to the U.S., had been the key to maintaining peace.

This fear was expressed in depth by Gen. Thomas S. Power, commander of the Strategic Air Command, in his testimony before a closed session of the Senate Preparedness Investigating Subcommittee. The testimony was severely censored before release, with any reference to electromagnetic pulse (EMP) phenomenon deleted from the text.

The possible effect of the burst of electromagnetic energy from an exploding high-yield weapon on the electronic circuitry of a missile is described as similar to what happens when lightning strikes a radio. It is believed to be capable of fusing wires, burning out circuits, and causing other extensive damage that would leave the missile inert in its silo, incapable of being fired or easily repaired.

In an article on radiation effects (M/R, Sept. 9, p. 19), John Crittenden, consultant in this field for General Electric, stated last week: "The detonation of (nuclear) weapons produces radiation over the entire electromagnetic spectrum.

"The prompt gamma pulse will affect electronic devices sensitive to ionization, and the radio-frequency signal propogated carries enough energy to damage electronic circuits drastically. . . ."

Experiments have shown these electromagnetic effects are effective far beyond the normal heat and blast effects of an explosion. In space, a one-megaton explosion can harm electronic systems over a radius of 110 miles or more, according to GE.

Extrapolation of this information to the effects of perhaps a 60-megaton Soviet weapon exploded in the atmosphere is difficult. This is one reason some U.S. military officers and scientists would like to see the U.S. undertake high-yield testing.

It is known that pulse radiation of Soviet high-yield nuclear tests in 1962 crippled the electronics of a U.S. satellite, possibly the one used to monitor those same electromagnetic effects.

● **Hardware affected**—The destructive effects of electromagnetic pulse on electronic systems include deterioration of semiconductors, current leakages, displacement or breaking of printed circuits and swelling of potting compounds and insulation used in electronic hardware.

As an example of the range of the effect, it can be disclosed that one of the U.S. nuclear tests in Nevada popped circuit breakers on power lines more than 100 miles away in California. Nevada tests are restricted to yields of 20 kilotons or less.

A Russian warhead of, for example, 60 megatons, releases most of its energy in the form of velocity of particles. This leaves about 10%—5% conservatively—distributed across the electromagnetic spectrum from hard protons of the gamma type all the way down to the very soft radio waves. One scientist emphasized to M/R, ". . . and 5% of 60 megatons is one helluva lot of energy."

In regard to electromagnetic effects of high-yield weapons, Dr. John S. Foster, Jr., director of the Lawrence Radiation Laboratory at Livermore, Calif., told the Senate Foreign Relations Committee Aug. 21 "It is simply that the question of how hard anything is to electromagnetic phenomena, be it anti-ballistic missile defense or hardness of silos, has to do with matters that, in my opinion, are not sufficiently well understood to be able to say with full confidence that they will function as designed in a nuclear environment."

He warned the committee that it would be taking an incalculable risk with the security of the country if it approved a treaty prohibiting further testing in the atmosphere.

The U.S. military already is financing development of electronic equipment less sensitive to radiation than that now used in U.S. missiles, but its effectiveness against high-yield explosions will be questionable.

● **Filling in the blanks**—With EMP in mind, examination of Gen. Power's testimony before the Senate subcommittee makes clear his concern with the phenomenon. (In the testimony quoted below, deletions made for security reasons have been replaced by the language which might have been used. This deletion and its replacement is indicated in italics.)

SEN. STROM THURMOND (D-S.C.): "If we are going to secure the second strike, then we have to be sure that our missiles can make that strike. And if (the Soviets) have tested and found out certain weapons effects and have found out that a certain yield weapon or a certain strength weapon can destroy our missile sites or destroy the *electronics* system, and if we cannot test any more to catch up with the knowledge they have gained, then can we assure immunity of our second strike, of our second missile system?"

Thurmond Statement

Sen. Strom Thurmond (D-S.C.), a member of the Senate Armed Services Committee, asked about the seriousness of the effect of electromagnetic radiations on missiles in silos, told MISSILES AND ROCKETS:

"By virtue of its large multi-megaton weapons tests, and what we know of these tests, we must assume that the Soviet Union has acquired a uniquely valuable body of data on radiation and electromagnetic phenomenon which is not now available to the United States and which cannot be acquired without atmospheric testing.

"Under such circumstances, we have a much lower confidence factor in the reliability of our *Titan* and *Minuteman* systems than would be the case were we in possession of such knowledge. This is among the most serious consequences which would flow from the test ban treaty if ratified."

GEN. POWER: "I would say this would be a tremendous advantage to the Soviet Union and a tremendous disadvantage to us, again depending on what they have found out." (This was followed by a classified discussion of EMP).

SEN. THURMOND: "And if they render our missiles inoperational through the knowledge they have gained and through the power they will have with this strike . . . then if that situation should come to pass, we don't have the manned bombers to make it, then where would we be?"

GEN. POWER: "We would be in trouble if this *electromagnetic* weapons effects phenomenon actually was as you described it. The point is I think we must find out. We must determine whether or not these things are true."

The reference by Sen. Thurmond to rendering missiles inoperational, in contrast to their destruction by blast or heat, may be considered a significant clue to the importance of EMP. Hardening and dispersal of U.S. missile sites had been based on calculation of heat and blast effects which would require almost a direct hit to destroy a missile in its silo. EMP, however, might be capable of incapacitating a great number of missiles at once.

● **Target programming erased**—The all-inertial guidance system of U.S. missiles such as *Atlas F, Titan II* and *Minuteman* are based on storing of target and guidance data on magnetic tapes or drums. In *Minuteman* silos, for example, a magnetic drum mounted on the silo wall contains information on more than one target, with selected target data fed to the missile before launch. A burst of electromagnetic energy might be capable of erasing such information, according to informed sources.

Gen. Power told the subcommittee that if it is found that a high-yield nuclear weapon has such destructive electromagnetic effects, the U.S. would want to employ its own ICBMs to do double duty as anti-ballistic missile system.

"That would give you much greater capability automatically," he said. "So it is a two-edged sword."

The subcommittee in its report to the Senate, after listening to 21 military and scientific witnesses, declared:

"The Soviets have overtaken and surpassed us in design of very high-yield nuclear weapons. They may possess knowledge of weapons effects and anti-ballistic missile programs superior to ours."

● **Russian test aims**—It noted that the character of the recent Soviet high-yield tests indicated they were centered upon anti-ballistic missile development. The report stated:

"It is prudent to assume that the Soviet Union has acquired a unique and potentially valuable body of data on high-yield blast shock, communications blackout and radiation and electromagnetic pulse phenomena which is not available to the United States."

But concern over what lessons may have been learned from high-yield tests was not limited to EMP. A "Hill" spokesman said there may be other "exotic" effects.

Sen. Robert C. Byrd (D-W. Va.), a member of the Armed Services Committee, was preparing last week to make a speech to the Senate floor expressing his fear that the Russians, through their high-megaton explosions, have gained other technical advantages the U.S. may not possess.

These, he felt, might enable them to create a communications blackout that could render U.S. missile sites, silos and electronic equipment useless. Sen. Byrd also was expected to point out his suspicion of the fact that the Russians, after previously refusing to sign test ban treaties, have reversed themselves about a year after conclusion of their last series of tests, about the time it might have taken to analyze the data. ■

At Edwards symposium . . .

Welsh Says U.S. Will Build Manned Space Stations

Manned PMR launches predicted; space rendezvous arresting gear, Gemini landing site selector, air-snatch booster recovery discussed

by Russell Hawkes

EDWARDS AFB, CALIF.—A top Administration official has announced that the U.S. definitely will build manned orbiting space stations.

Dr. Edward G. Welsh, executive secretary of the White House's National Aeronautics and Space Council, also indicated that the U.S. is considering launching manned spacecraft from the Pacific Missile Range.

Addressing the Symposium on Space Rendezvous, Rescue and Recovery at Edwards Air Force Base, Calif., Dr. Welsh said "There has been a lot of talk and some studying on the subject of space stations. There will be more of both.

"The question is not whether we will have orbiting space stations. The question is when and what will they look like," he declared.

Turning to the future, Welsh suggested some advanced considerations which merit examination in terms of the national space program.

● **Non-orbiting rendezvous**—The first, he said, is direct ascent rendezvous. Pointing out that the U.S. has been forced to operate with weight-limited launch vehicles, he said that inadequate payload margins have required us to plan in-plane launches and parking orbit techniques in order to rendezvous.

"With the *Saturn* and *Titan III* boosters now on the horizon, such constraints will soon be lessened. It is possible to consider the operational potential and mission flexibility that accrues from non-coplaner launches, direct ascent techniques and inspection rendezvous options," he told the meeting.

The space council official also called for consideration of the implications, benefits and problems associated with expanding U.S. mission profiles, including polar orbit launches.

He warned those at the meeting that it would be shortsighted to think in terms of recovery operations, techniques and sites that are only applicable to today's low-inclination orbits, and which overlook the ever-broadening base of the national space program.

His reference to polar orbit missions implies that U.S. space officials are considering the Pacific Missile Range as a base for future manned space flights.

Such orbits cannot be achieved with launches from Cape Canaveral because of its location. They are possible, however, from West Coast launch pads.

● **Boosting Apollo**—Welsh also rejected reports that the Soviet Union may be losing interest in a manned lunar landing program and made a ringing defense of this country's Project *Apollo*.

"Recently, there has been a view expressed that Soviet officials were dubious about the value and uncertain as to the possibility of putting a man on the Moon. I attach little weight to this view. However, it would help them if they could encourage a U.S. slowdown. Certainly the idea that they were withdrawing from the race could slow down our effort even though it shouldn't.

"It is worth keeping in mind that irrefutable facts and events demonstrate that the Soviets are conducting a vigorous space effort, and the evidence is strong that this program includes a manned lunar trip," Welsh told the meeting.

"Let me emphasize that we should be making a vigorous effort to go to the Moon and that we should continue to do so even if the Russians delete such an objective from their space program," he added.

● **Lunar mission advantages**—In defending NASA's Project *Apollo*, Welsh said that:

—There is no other place so near in space where we can test the equipment and the men for future space travel.

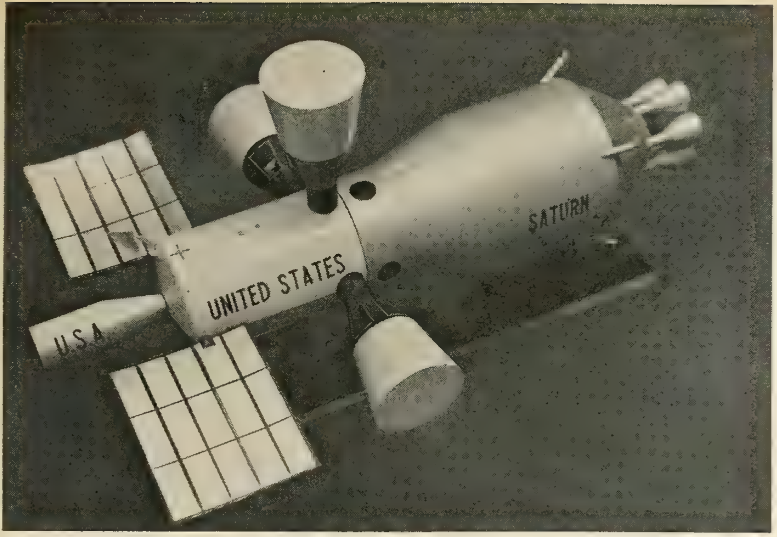
—Such a clear objective as that of the lunar project gives impetus, order and efficiency to the program.

—To go to the Moon requires development of powerful rocket engines, sophisticated spacecraft, trained astronauts, tracking systems, and the capability to protect man against the multiple hazards of space—all of which are useful and necessary for space progress in general.

—Success in the lunar project will give prestige that will be invaluable to U.S. officials at international negotiating tables.

—The benefits to the nation's standard of living, to education and employment and to new methods and materials for our productive process will be great, though not capable of being measured.

—While the Moon itself is probably



THIS 1/30 SCALE MODEL of a proposed Manned Orbiting Research Laboratory system is under investigation at NASA's Langley Research Center. MORL is based on maximum use of NASA systems being developed or in existence. This study model shows one concept using the S-IV Saturn stage. Attached are three Gemini spacecraft for crew changes, and an Agena resupply vehicle. The MORL would be sun-oriented.

not a particularly significant military objective, the lunar project will have substantial defense spinoffs. Rendezvous technique, life-protective measures, control and guidance systems and improvements in rockets will all contribute to the basic objective of deterring aggression.

—The Moon has many scientific advantages. For example, it would be an excellent platform for mounting astronomical instruments. Moreover, it could be a relay point for communications and a refueling point for space travelers.

• **Other systems aired**—An arresting gear to terminate space rendezvous operations without delicate docking maneuvers was among the fresh approaches to the problems of space flight discussed at the symposium.

Others were on-board navigation equipment to permit *Gemini* astronauts to select their landing sites without assistance from the ground, and a proposal to recover space boosters by a variation of the air-snatch technique used successfully to recover *Discoverer* spacecraft.

The case for arrested rendezvous was put by David C. Weiss of General Dynamics' General Atomics Div. Its advantages include greater freedom of launch time, more efficient terminal propulsion, lighter demands upon the pilot during the terminal maneuver and the ability to join a non-cooperating satellite.

Comparison of the weight of propellant for rendezvous terminal phase with that of arresting gear shows a substantial advantage for the latter in General Atomic calculations.

Disadvantages are the effect of the emergy dissipated in the engagement upon the satellite orbit and attitude. However, General Atomic engineers have concluded that for relative speeds of several hundred feet per second, the perturbation of the space station orbit can safely be ignored. The cumulative effect of many arrested rendezvous is expected to cancel any single perturbation.

• **Chrysler proposal**—A related technique was suggested by J. P. Dei and C. E. Mair of Chrysler Corp. for the recovery of boosters. The authors were interested in improving the economy and hence the market for Chrysler-built *Redstone* boosters, but their proposed air-snatch method of recovering boosters using large helicopters to carry the pick-up gear might be applicable to the recovery of any medium-sized space boosters.

Unlike most concepts for making boosters re-usable, this one does not penalize payload by requiring the booster to carry a great weight of recovery systems.

After the initial deceleration of the booster by its own aerodynamic drag, a controlled descent is established with reefed and clustered ribbon-type parachutes. The hook for the air-snatch operation is held well above the main chute cluster by a separate drogue.

Aboard the helicopter, the loop of the snatching cable is held well forward in the pilot's field of vision by a pair of poles. At contact, the loop would be pulled away from the poles, would ride up to the hook above the booster and would begin to take cable from a friction winch installed aboard the helicopter to absorb the impact of the engagement.

About 150 ft. of cable pay-out would be needed to keep accelerations at roughly 1 g for a 10,000-lb. load. The main parachute cluster could be allowed to separate after being relieved of load.

Parachute-borne 1,000-lb. weights have been recovered by helicopter in experiments at Holloman AFB, N.M.

• **Gemini landing system**—Because the *Gemini* spacecraft may be cut off from ground command guidance stations for three orbits, it will carry an on-board navigation and landing site selection system.

The system, described by M. J. Schrader of McDonnell Aircraft Corp., will make use of available display and input-output equipment and part of the capacity of the IBM on-board computer. Selection of landing point without continuous ground station guidance is made possible by computer prediction of spacecraft orbit from initial data transmitted to it by one or more ground stations.

A complete orbit can be predicted in less than three minutes. By plotting this orbit on a strip map, an astronaut can evaluate potential landing sites. The map and the plotting instruments are the only additional components required for the proposed system.

Having selected a site that can be reached from the predicted orbit, the astronaut will enter an estimate of time for retro-rocket fire into the computer, by means of a keyboard.

Comparison of touchdown predicted for this time of firing with the touchdown required will give him a revised estimate for the time of firing.

Successive revision of this sort should quickly yield the correct retro-rocket firing time, but simulation experiments are necessary to evaluate how a man performs in such a situation.

The method of successive approximation could be made automatic if there were more computer capacity available.

• **Re-entry guidance**—Guidance of *Gemini* during re-entry is provided by steering commands derived from an inertial guidance system.

From the output of the inertial measuring unit, the on-board computer predicts the touchdown point for a zero-lift trajectory during the remainder of the flight. Resulting downrange and crossrange errors in relation to the desired touchdown point are used to develop roll angle commands. ■

Martin Laser Highlights MIL-E-CON

Pulsed output unit would boost gas system from lab device to practical medium-power tool; nuclear lasers discussed

by Charles D. LaFond

ADVANCED LASER RESEARCH at Martin Co.'s Orlando Div. has resulted in development of a pulsed gas-type laser that produces more than 50-watt peak power with repetition rates up to 5,000 pps.

By employing a technique for producing rapid population inversion during pumping in the 50:1 ratio helium-to-neon gas mixture, Martin scientists have been able to achieve rapid, sharp pulses.

First details of the new laser approach were described in Washington last week at the Seventh Annual National Convention on Military Electronics. In addition, Martin scientists revealed other laser efforts being studied by the division, including semi-active guidance for short-range tactical missiles, and (for the future) X-ray, gamma-ray or neutron direct pumping. Also suggested was the possibility of producing higher power millimeter-wave radio signals by beating two optical frequencies together.

- **Information and C & C**—With more than 4,500 in attendance and a packed exhibition hall, last week's MIL-E-CON 7 was labeled by conference officials an unqualified success.

Two panels and 10 technical sessions produced 110 papers that covered a large part of the electronics spectrum, but were directed to the general subject of National Information and Command and Control Systems. The three-day meeting was sponsored by the Institute of Electrical and Electronic Engineers.

In the keynote address, Dr. Chalmers W. Sherwin stressed the need for proper management of U.S. science and technology to protect the public interest. Federal R&D alone, the Deputy Director of Defense Research and Engineering pointed out, consumes nearly $15 billion or 3% of the Gross National Product.

Thus, he said, within one generation, science and technology have become "the primary basis of national wealth and military power and also a primary tool of social and economic revolution."

To help solve the newly created but growing management crisis developing as a result of the magnitude of the national R&D effort, he suggested that the technical community assume more responsibility in producing more technically oriented managers, in encouraging more scientific and technical personnel to enter public service and in pressing for the preservation of technical competence in its professional ranks.

- **Martin laser**—The employment of a gas laser as a pulse-output device instead of the more conventional continuous-wave system has resulted in raising the gas laser from a low-power laboratory device to a practical medium power system.

Martin's present experimental helium-neon laser employs a 3-in.-dia. tube to produce a 0.25-μsec pulse at 2,000 cps and a 50-kv peak power pump input. Researchers indicated that outputs in the kilowatt range soon will be obtainable.

Average power is about 100 mw, or higher than any known gas CW laser, company officials declared.

For optimum output, a pressure of about 20 torr is maintained; however, highest peak power output was achieved with pressures of 100 torr helium and 2 torr neon in the 130-cm.-long tube.

Brewster-angle end windows are flat to 1/20 wavelength; the external Fabry-Perot resonators are flat to 1/50 wavelength.

- **Future applications**—To demonstrate laser applications, the Orlando engineers built a laser ranging device having a maximum range of 9,990 meters and a 10-meter resolution.

Completely self-contained, including power pack, the device uses Q-switching pulse-modulation to produce short-pulse high-peak-power output. Electronics are transistorized. Readout is by nixie tubes.

The ruby laser generated approximately 100-kw peak power with a single 60-nanosec. width pulse. Beamwidth was 1 milliradian.

The 40-lb. instrument (excluding tripod and head) has a firing rate of two per minute.

A xenon flash tube provides the light (pump) source. Such an instrument could find use not only for ranging in the field, but could be employed to illuminate a target to guide an optical-frequency homing missile. An improved single-cavity unit with a 10-20 pps output or a Gatling-gun laser would be required.

Tests results so far with the Martin pulsed gas laser have shown its high potential as a key element in an optical radar. Effective ranges up to 10 km. for non-cooperative targets and 100 km. for cooperative targets are considered practical.

With higher peak powers and more sophisticated detection techniques, the researchers predicted ranges of 1,000 km. in the future.

The pulsed gas laser approach could lead to development of a coherent doppler lasar, said Dr. Roy C. Weidler, chief of Martin-Orlando's Electro-Optics Research Laboratory. Attempts to develop such a system have been limited in the past by low power and low repetition rates.

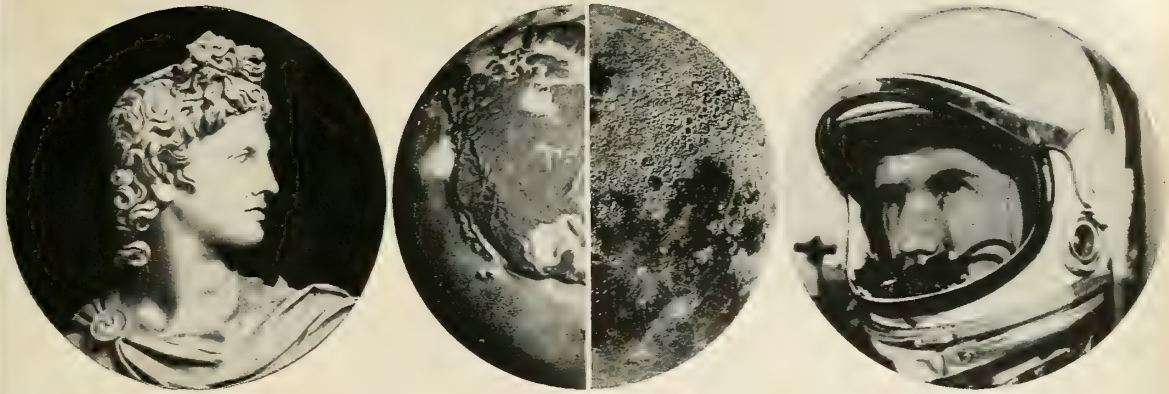
With solid lasers (for missile guidance or tracking), Weidler pointed out that devices achieving 5-cps, 1-megawatt outputs have been produced. And with improvements already contemplated, 10-cps repetition rates for up to 5 or 6 hours operation are possible.

While ranging or tracking laser systems will see some use in the future at ground stations, Weidler predicted that the greatest potential for such systems will be in space—for rendezvous, reconnaissance and possibly long range detection and tracking.

- **Nuclear lasers**—Another area of laser research long under study by Martin has been the use of X-rays, gamma rays and neutrons for directly pumping a laser. Scientists admit the hazy potential of such a device, but they point out that the limiting factor today in producing a laser kill system is the power required.

For space use (to be beyond the intolerable attenuation of the Earth's atmosphere), a compact high-power source would be required. Direct pumping would further simplify such a system and thereby might make practical a laser-beam weapon system capable of long range use in space or short range tactical use on the ground. ■

GENERAL ELECTRIC ENGINEERING OPPORTUNITIES



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>
> National Aeronautics and Space Administration
> at the Aeronautics and Space Committee Hearings,
> U.S. House of Representatives, 1963.

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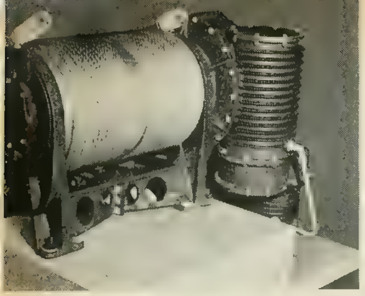
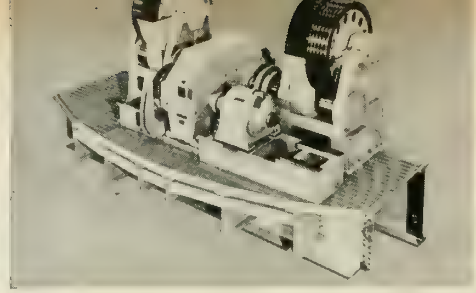
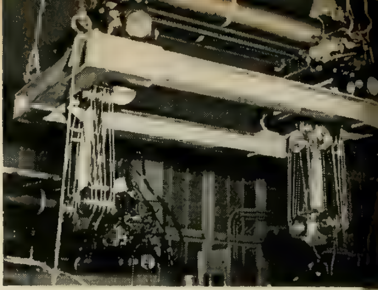
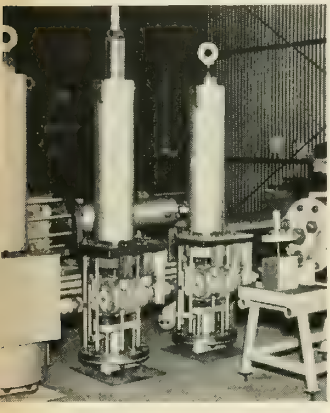
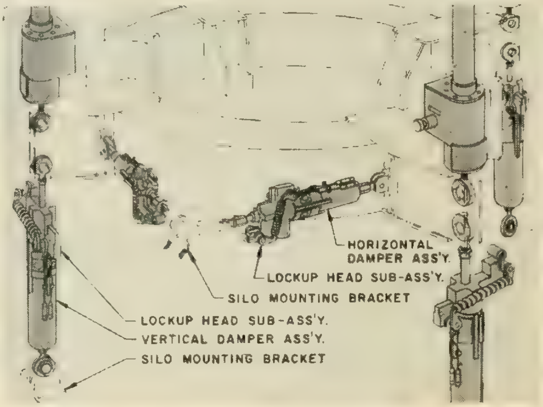
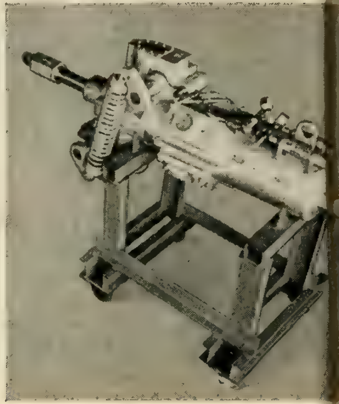
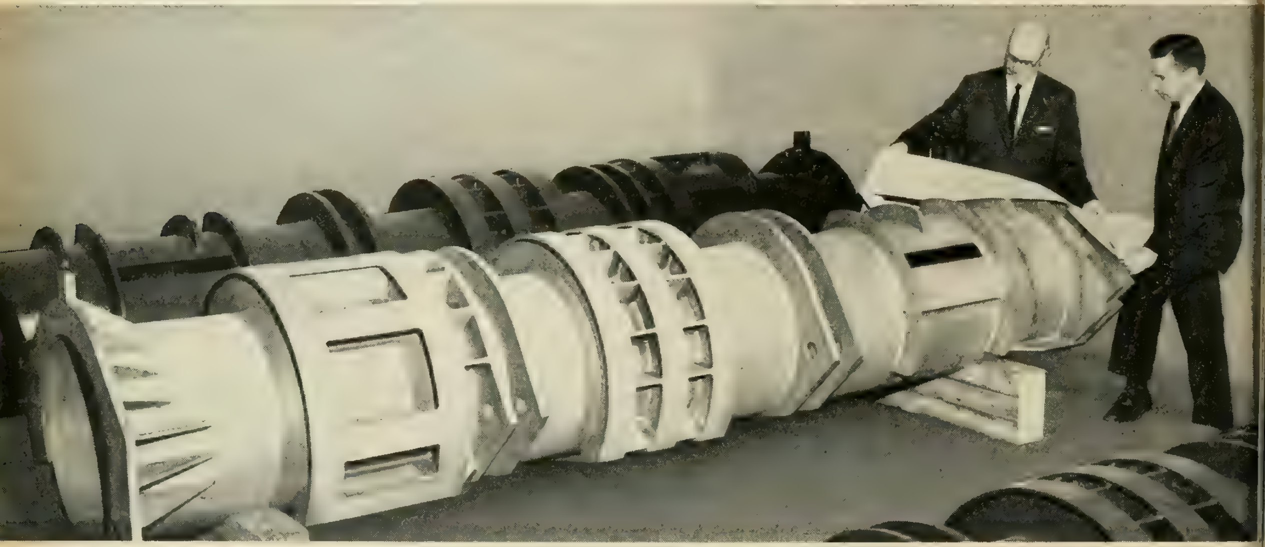




HOISTS—Western supplies these heavy duty hoists for (1) Nike Zeus (2) Atlas and (3) Minuteman missiles.



SHOCK ISOLATION—Vertical and Horizontal damper assemblies of Western's Shock Isolation System for the Titan II.



SPRING CAN ASSEMBLIES—Built by Western as a precision component in the Minuteman missile silo system.

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Surprised? This heavy equipment for missile ground handling and positioning is far removed from the lightweight airborne gear drives you probably know us for. You'll want to keep track of how our capabilities keep growing.

For example: Hoists for the Atlas, Minuteman and Nike Zeus. Damper assemblies for the Titan II's in-silo shock isolation system. Spring can assemblies for the Minuteman's silo system.

These are just samples of Western's capabilities in ground handling, missile positioning and shock isolation equipment. Don't they suggest that you call on our "missile muscle men" as a reliable source for this type of gear? Write or call for prompt attention to your newest problems. WESTERN GEAR CORPORATION, Precision Products Division, P.O. Box 192, Lynwood, Calif. Cable address WESTGEAR, Lynwood, Calif.

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Technical Countdown

ELECTRONICS

Digi-Comb Under Contract

Goddard Space Flight Center has awarded a $136,000 contract to Ortronix, Inc., Orlando, Fla., for Digi-Comb, a segment of a pulse frequency modulation telemeter system for advanced satellite programs. The Digi-Comb, privately developed by Ortronix, is a solid-state system capable of detecting and conditioning weak telemetering signals from satellites in space. The system consists of 128 active tracking filters arranged to detect telemeter data being transmitted. The filters are pre-conditioned to detect extremely weak signals even under severe interference or noise conditions. The output represents the reconstructed signal as well as a binary level indicative of the transmitted data. The outputs are synchronized, regenerated and formated for data reduction.

ITT Laser in Materials Research

A pulsed ruby laser producing an energy output of 500-700 joules is being used in materials and biomedical research at the Federal Labs of International Telephone and Telegraph Corp. The laser is of the multicavity type with automatic liquid nitrogen cooling of the ruby rod. Energy for the four flashlamps in the head is stored in a 10,000-microfarad capacitor bank. A laser peak power output in the gigawatt range is reached with Q-spoiling techniques.

Improved Thermionic Generator

The thermionic conversion laboratory of General Electric's Vallecitos Atomic Laboratory is operating a *SNAP*-type thermionic generator with an efficiency of 3.6%. The increase over the normal 2% is attributed to use of a highly-conductive bond between the thermoelectric material and its iron terminal. Developed under an Air Force contract, the experimental device provided an initial output power of 0.5 watt at 0.57v. Lead telluride (P and N types) is formed into a sintered rod and simultaneously bonded to an iron current terminal by a hot-pressing operation. The sintered thermionic material is then loaded into axial channels in a cylinder of thermally-insulating fibrous compound. In each channel, P- and N-type rods are separated axially by a rod of thulium 170, of the same diameter. Radioactive decay of the thulium raises its temperature to 500°C. All machining operations on the thulium can be carried out before it is rendered radioactive. Its short half-life is advantageous from a safety point of view.

Martin Pulsed Laser Peaks Over 50 Watts

In a research effort aimed at optical radar, Martin-Orlando scientists have perfected a pulsed gas laser with a pulse repetition frequency of 2,000 cps and a pump input of 50-kv peak voltage in 0.25-μ/sec. pulses. The high power and pulse repetition frequency are attributed to a rapid inversion technique developed at Martin. The laser uses helium and neon in a 50:1 mixture. The laser tube is 130 cm. long with an inside diameter of 3 cm. The ends are Brewster angle windows, flat to 1/20 wave length. The external Fabry-Perot resonators used are flat to 1/50 wave length and coated for maximum reflectivity in the 1.15-micron operating wavelength. The output is uniform over the 3-cm. aperture.

SPACE MEDICINE

O_2 Revisited

Latest Air Force data indicates that, at 5 psia (258 mm Hg), 100% oxygen can be tolerated for 14 days, but symptoms similar to those of oxygen toxicity were encountered in all subjects. These were limited to eye irritation, aural atelectasis, and erythema of the posterior pharynx. Substernal pain and a possible case of anemia were also noted in the four men who were exposed in two 14-day experiments.

Eyeball Movement in Zero-G Studied

An electrical stimulation of the vestibular system may be developed to prevent disorientation in astronauts who leave space capsules in free space. ITT Data and Information Systems researchers are completing a study on visual disorientation. One conclusion: eyes of astronauts will roll involuntarily because of lack of gravity, and electrical stimulation may be the remedy. ITT also is conducting a number of studies on confinement, effects of body position, and human ability to interpret and identify photographic material.

Advanced Materials

Lithium Hydride Shields SNAP 10A

Specially purified lithium hydride powder, isostatically compacted, machined and encapsulated in stainless steel, is being used by Atomics International, division of North American Aviation as a shield in the SNAP 10A reactor. The shield is produced by Union Carbide in the Atomic Energy Commission Plant Y-12 at Oak Ridge, Tenn. The pressing operation phase of the fabrication process is reportedly not available through normal industrial channels.

Emerson's WASP Funded by Army

Emerson Electric Manufacturing Co. will deliver to the Army a prototype of its *WASP* helicopter rocket system, together with enough rockets to conduct feasibility demonstrations. The system is the result of a company-sponsored program, and the contract from the Army Missile Command's Anti-Tank/Aircraft Weapons Commodity Office will involve further development and design refinements. The weapon is to provide high density fire power for area coverage.

Acoustic Test Facility Nears Completion

A high intensity noise facility capable of withstanding sound pressures in excess of 500,000 watts will soon be in operation at Aerotest Labs in Deer Park, N.Y. Designed for use in two configurations, the reverberation chamber can accommodate vehicles up to 100 ft. in length. In this form, the chamber has a total volume of 40,000 cu. ft. A smaller arrangement permits testing in a 20 x 20 x 27-ft. chamber. Acoustic equipment now being installed will have an output rating of 20,000 acoustic watts and sound pressure levels up to 20 db. Broad-band noise up to 40,000 cps is available, as are spectrum shaping and discrete frequencies.

Stanford Electronics Labs Pursues Laser, Ion-Propulsion Studies

by Rex Pay

STANFORD, CALIF.—A new laser ranging system, the generation of green laser light, and detection of frequency-modulated laser signals are lines of research showing promise here at the Stanford Electronics Laboratories.

Under NASA, Air Force and industry contracts, SEL also is carrying research on ion propulsion, including a means of designing ion thrustors by a computer program.

Other SEL developments reported at a recent industry conference here include:

—Preliminary analysis showing that all ion exhausts will be unstable—but the extent of the instability has not been predicted.

—Establishment of a suitable source for high-intensity pulsed ion beams.

• **Laser ranging**—New possibilities in laser ranging stem from a striking effect seen when CW gas lasers operate in the visible spectrum. When the visible beam meets a scattering area, such as a piece of paper, the illuminated spot has a sparkling granular look. This turns out to be a random stationary diffraction pattern, made up of needle-like lobes similar to those in the far field of a randomly phased radio antenna array.

If the scattering surface moves, a large transverse movement of the pattern takes place. SEL's Dr. W. H. Huntley, Jr., suggests that this movement can be used to instantaneously measure the tangential velocity of a target.

Investigation indicates that metallic surfaces afford the same random intensity pattern as paper surfaces. But the polarization of the reflected wave is not randomized, as it is from paper.

Combination of the tangential velocity with data obtained from conventional radar and doppler techniques would completely specify the target's position and velocity. This could be done continuously, with relatively simple equipment.

For detecting movement of the diffraction pattern, an array of detectors would be needed, says Huntley, perhaps a circular array. These would be interconnected by equipment that would evaluate the correlation between individual detector inputs.

If the detector array is a long way from the target and has a small aperture, any tangential motion of the target will produce large fluctuations in the detectors. The degree of correlation between fluctuations in detectors at opposite sides of a circular array would provide means to measure tangential velocity.

By modulating the transmitted laser beam, range and radial velocity data could also be extracted.

Huntley sees target acquisition as a big problem for such systems.

• **Green lasers**—To achieve solid-state lasers with outputs in the green part of the spectrum or in the ultra-violet, intense light sources very rich in ultra-violet light probably will be required.

A way of achieving this with commercial xenon flashtubes was described by Dr. A. L. Schawlow. Current densities of 25,000 amp/sq. cm. have been passed through tubes that usually explode at such current levels. Wavelengths below 3,000 Å were raised 250 times above normal peak intensity.

Solid-state lasers so far have produced light only in the red end of the spectrum. But green light is thought suitable by some for penetrating sea water, and other wavelengths are needed to increase the flexibility of lasers.

Research is under way at SEL into materials that may be capable of lasing at green wavelengths, notably rare-earth doped compounds with ultra-violet absorption bands. But, because xenon tubes are used almost exclusively as a pump source for laser materials, development of a high ultra-violet output from such tubes is essential if the new materials are to be usable.

The technique for producing high outputs is to pass two consecutive pulses of current through the tube. In commercial tubes with 7-mm. internal diameter and 75-mm. electrode spacing, a current density of 25,000 amp/sq. cm. was achieved for a few microseconds by first forming a stable discharge at about 2,000 amp/sq. cm. A minimum of 75 μ sec was required between the setting up of the stable discharge and the passage of the peak current. Otherwise the peak current bursts the tube.

A double-pulsed lamp would probably raise the laser power output to five to ten times that reached with a conventional lamp. Improvement in lamps might lead to giant-pulse operation of lasers without external amplifiers.

A lamp of this type may have other advantages, said Schawlow. It could enable the use of more concentrated laser materials, even though these have shorter fluorescent lifetimes.

Similarly, a lamp of this type might be used to produce coherent light from a ruby that is heated to broaden its band of output frequencies.

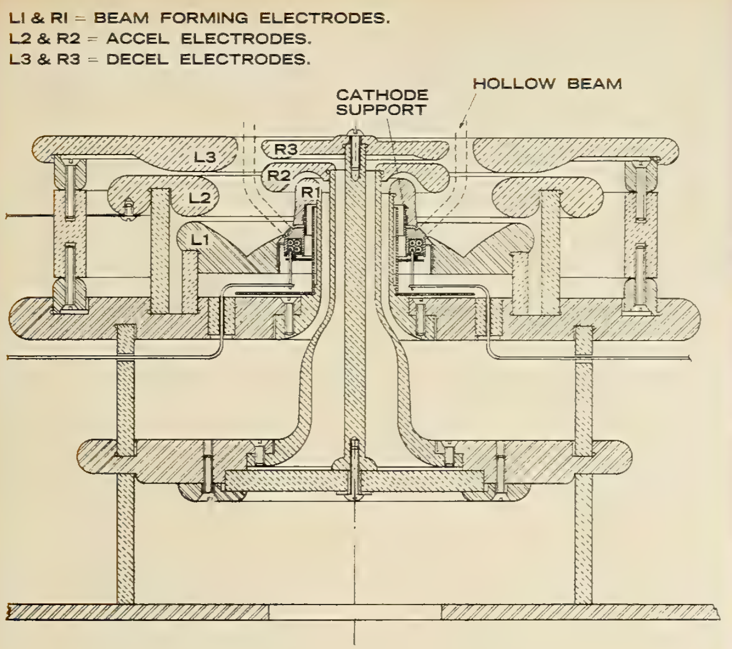
One of the materials being studied at SEL as a possible generator of coherent green light is the rare earth, terbium, reports Dr. W. W. Anderson. This has emission lines in the green end of the spectrum but is characterized by very weak fluorescence.

Sensitized luminescence offers a means of enhancing intensity of the green light emission. In this technique, the rare earth is doped into a semiconductor. Incident energy is absorbed by a center in the semiconductor and then transmitted through the lattice to the terbium, which emits a photon.

For this process to operate, the band gap of the host should be at least as great as the gap from the lowest metastable state of the rare earth to its ground state.

Zinc sulfide meets this requirement at a temperature of 77°K.

Experiments with zinc sulfide doped with terbium have produced emission lines between 5,434 and 5,496 Å with bandwidths of about 3 Å. These bandwidths are considered very useful for laser applications; but it is not clear yet whether sensitized luminescence is really taking place.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L3 & R3 = DECEL ELECTRODES.
CATHODE SUPPORT
HOLLOW BEAM
L3
R3
R2
L2
R1
L1

CROSS-SECTION of hollow-beam ion gun.

One of the problems that has been encountered has been difficulty in inserting the rare-earth metals into the crystal lattice of the semiconductor. A way of doing this might be direct implantation by ion bombardment.

- **Detecting FM light**—Frequency-modulated light has a number of advantages for optical communications systems. In particular, the interfering effects of spurious amplitude modulation occurring along the light beam can be minimized.

For detecting light that is frequency modulated in the gigacycle range, Dr. S. S. Harris has developed a simple device made up of two bi-refringent calcite crystals. It converts FM light into AM light, which can be demodulated by photoelectric devices. There is no transmission loss, and spurious amplitude modulation on the incoming signal is suppressed.

Theory indicates that the crystal length in a device will vary with the frequency to be detected. This sets the limits for the demodulator's useful frequency range.

For detecting 80-gc signals, a 1-cm. crystal is required; for 10-gc, an 8-cm. crystal; for 1.1-gc, a 70-cm. crystal.

For a given crystal length, the theory shows that efficiency of FM/AM conversion falls off by 3 db over a 2:1 frequency bandwidth. AM suppression is greater than 20 db over a bandwidth 40 per cent of the center frequency.

Experiments with 5-, 6-, and 11-cm. crystals at frequencies between 3 and 10 gc "are in excellent agreement with theory," reports Dr. Harris.

The complete FM/AM converter—the optical ratio detector—consists of a polarized filter followed by two highly birefringents calcite crystals. Biassing of the first crystal is required, and is achieved by rotating the crystal slightly so that the light beam passes through it at a skew angle.

- **Ion exhaust instability**—Because ion propulsion demands neutralization of the exhaust ion beam by addition of electrons, an ion thrustor exhaust forms a plasma. Theoretical analysis of the stability of plasmas of this sort by Dr. H. Derfler shows that they are unstable with respect to small perturbations.

The character of the instability depends on whether the mean thermal speed of the electrons is greater or less than the velocity of the ions. However, in free space the ions must be faster than the electrons.

To date, only small-signal linear analysis has been carried out. This predicts growing oscillation in the motor exhaust, but does not indicate how big the oscillations might become. There is the possibility that violent oscillations may develop. "Since violent oscillations may interefere with operation of the motor, a more comprehensive non-linear analysis is essential to determine the feasibility of ion rockets in free space," said Derfler.

- **Ion source**—Pulsed ion emission currents of 83 ma/sq. cm.—equivalent to 1 ma/sq. cm. continuous for 30 to 40 hours—have been drawn from a lithium-alumino-silicate, spodumene, reports Dr. R. P. Lagerstrom.

Formed as a ¼-in.-dia. button, the emitter was equipped with an imbedded heater. It was operated at 1,165°C, which is 260°C below the melting point of the glassy ceramic spodumene. Peak current densities were obtained with 4-kv pulses applied to a diode with a 0.16-cm. emitter-to-collector spacing.

Neutral lithium emission was less than 1%—the limiting sensitivity of the measuring equipment.

Promising as these results are, a number of problems have to be overcome before the emitter material can be used in practical thrustors.

Continuous operation is desirable and long operating periods would call for some means of transporting lithium into the material continuously. Also, replacement of the lithium by a heavier material such as cesium is needed.

Emitters made from this material are rugged. They have withstood many on-off cycles of heating and have been exposed to air while hot.

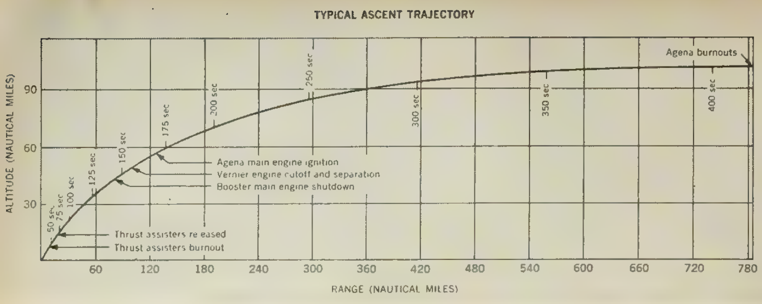
- **Ion gun design**—A method of designing ion guns by means of a computer program has been developed by a SEL team under Professor G. S. Kino. A report on this method has been sent to the Lewis Research Center for review as a manual for electrode design.

To get a high ratio of accelerating to decelerating voltage, and to reduce radiation losses from the heated emitter, a curved trajectory was selected for the ion beam within the ion engine.

A gun has been designed and fabricated using this program. But for experimental convenience, the design is for electron rather than ion emission. In this form it will be used to evaluate space-charge problems and the optical characteristics of the system. Ultimately a cesium ion emitter will be used.

A paramount feature for long operating life of an ion engine is almost-perfect ion optics and the greatest possible reduction in the heat loss by radiation into space. Two further constraints on ion optics design are the need for convergence of the beam and achievement of the correct exit condition for beam neutralization.

The computer program provides a design that meets these criteria; but this design usually has to be modified to avoid voltage breakdown and to make fabrication possible. The adjustment necessary to meet these requirements can be entered into another program and the effect on the ion optics calculated. By repeating the two programs alternately, a practicable and efficient ion gun can be obtained. ■



Trajectory analysis, directly affecting payload capability, is vital to any satellite flight. As Lockheed Missiles & Space Company is responsible for the orbiting of over 60% of all U.S. satellites, considerable effort has been given to the study of vehicle dynamics-performance problems.

The result: Many trajectory problems are being solved routinely through the use of automated computer programs. Some of these in use at Lockheed are: Optimal trajectory shaping programs, maximizing payload weight capability for a given set of mission parameters • Targeting programs for specific configurations, which automatically develop ascent trajectories and orbit ephemerides • Automated trajectory programs for generating dispersion analyses needed to establish propellant margins and expected injection errors • Post-flight analysis programs which establish the actual subsystem flight performance characteristics.

As missions become more complex and demanding in terms of payload capability, accuracy requirements and mission flexibility, the sophistication of ascent and orbital systems increase, demanding greater detail of trajectory and performance analysis. Engineers and scientists at Lockheed are continually expanding their capabilities to meet these needs.

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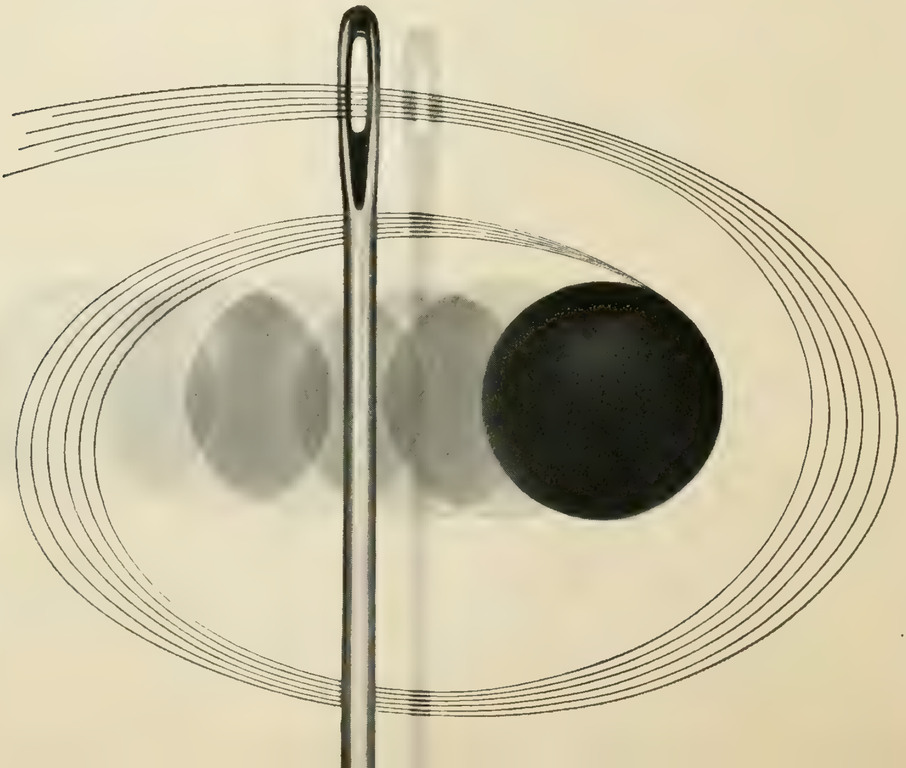
LOOK AT LOCKHEED...IN TRAJECTORY ANALYSIS

Automation of highly complex trajectory programs



Chemosynthetic Oxygen System Being Tested

by Heather M. David

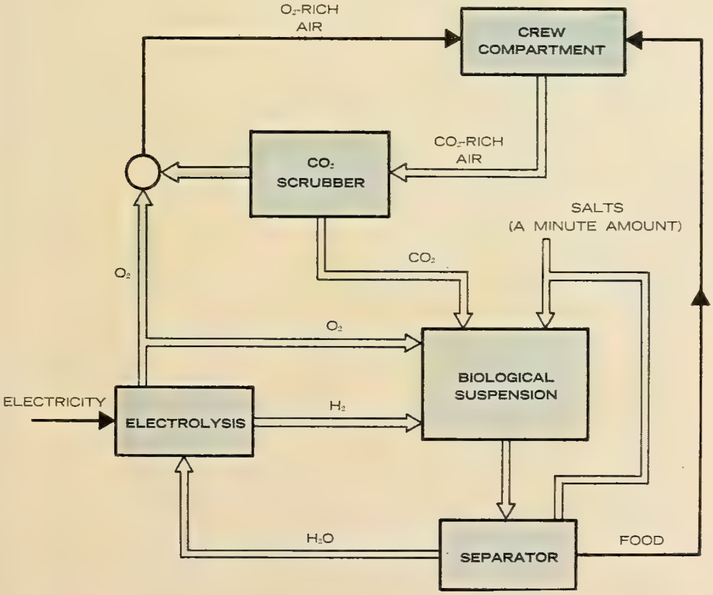
A NEW DEVELOPMENT has been reported in long-term oxygen supply methods that may make an algae system obsolete before it is ever flown.

The "chemosynthetic" system, which employs a combination of electrolysis and hydrogenemonas bacteria, may require only ⅒ the power supply and ⅕ to ¼ the weight of plant systems, Martin Co. scientists recently told the American Institute of Biological Sciences. NASA has been watching development of this type of system with considerable favor.

Laboratory-scale experiments in both photosynthetic and chemosynthetic systems have been conducted by Drs. Leonard Bongors, space programs research scientist at Martin-Baltimore, and Bessel Kok of Martin's Research Institute for Advanced Studies (RIAS).

The chemosynthetic system for three men, they said, would probably weigh about 284 lbs. and require approximately 2,600 watts continuous to operate. A photosynthetic system for three men, they added, would weigh about 784 lbs. and require 25,000 watts. If direct sunlight could be used, weight would be 1,200 lbs., and power would be 600 watts (continuous). However, solar illumination presents radiation problems and other complicating factors.

The chemosynthetic system has considerable power savings over physical reduction methods, which break down CO_2 with hydrogen, then use electrolysis to recover oxygen from water. Biological reduction takes place at low temperature, while physical reduction requires elevated temperatures and a greater power supply, Bongers said.



BLOCK FLOW diagram of chemosynthetically balanced closed ecology.

Another advantage is that because biological reduction does take place at room temperature, there is no need to dump excess heat generated by the system.

While large-scale experimentation must be done before these figures can be verified, the approach seems most promising, the scientists said. The Martin Co. and RIAS researchers are carrying out a larger research program this year, with some NASA support.

- **How it operates**—The system in its simplest form is two units, one an electrolysis cell, the second a "suspension" of hydrogen oxidizing bacteria, a number of which are being considered.

Respiratory products of the crew are fed into the biological suspension (which also receives hydrogen from the electrolysis). A minute quantity of salts (nitrogen, phosphorus and potassium, for instance), is added as "fertilizer." Through the combustion of hydrogen, the hydrogen-reducing bacteria convert the carbon dioxide and salts into water and a potential food material, which Dr. Kok described as much like algae, but colorless.

These are separated, with the food harvested for the crew and the water going into the electrolysis cell. This cell recovers oxygen for the crew and provides hydrogen to support the bacteria suspension.

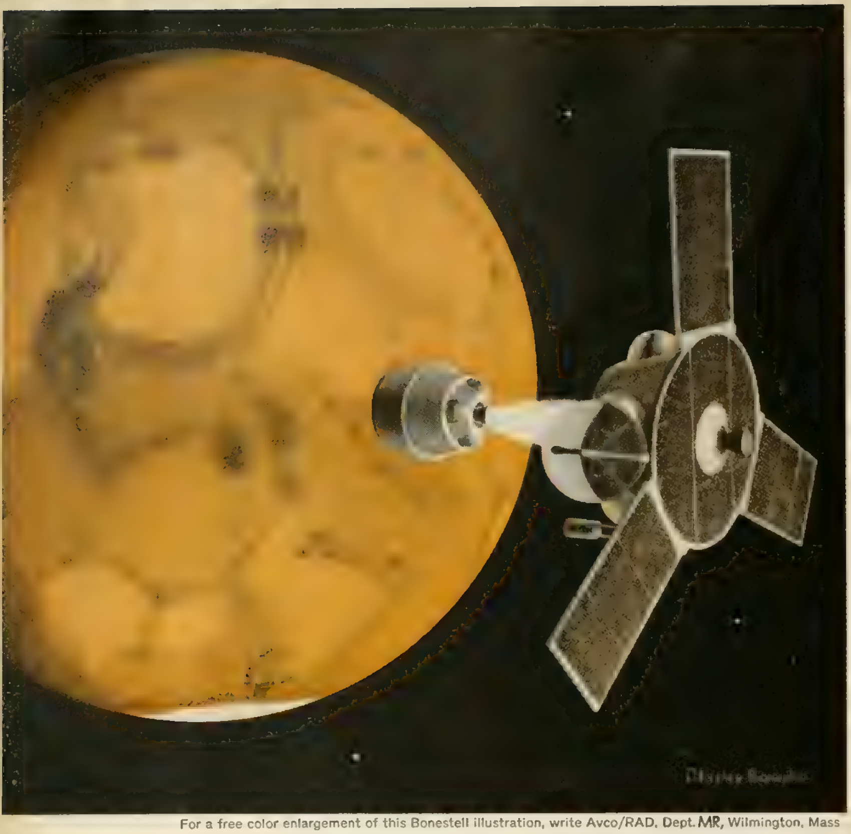
These reactions take place: Respiration: $CH_2O + O_2 \rightarrow CO_2 + H_2O$. Synthesis: $CO_2 + 6H_2 + 2O_2 \rightarrow CH_2O + 5H_2O$. Electrolysis: $6H_2O \rightarrow 6H_2 + 3O_2$.

- **Efficiency**—Laboratory tests illustrated that one liter of hydrogen-oxidizing bacteria can consume two and one-half liters of carbon-dioxide every hour. At this rate, 10 liters of suspension containing 200 grams of dry cells would maintain one man's oxygen supply.

However, in view of the uncertainties of the system, the Martin researchers make a more conservative estimate that about one-half this efficiency will take place. Thus, they say, 60 liters would maintain three men, removing respiratory carbon dioxide and generating about that much food.

Work this year will continue on studies of about a dozen strains of bacteria, all of which are hydrogenemonas. Actual tests with human subjects probably will not be made in the near future, Kok said, but laboratory equipment will simulate the consumption of oxygen and metabolic activity of men. Also, in spite of the fact that the bacteria studies seem quite impervious to diseases, the researchers will try to determine if there are any things which might unbalance the suspension.

There are no present plans to put other metabolic waste products into the system. ■



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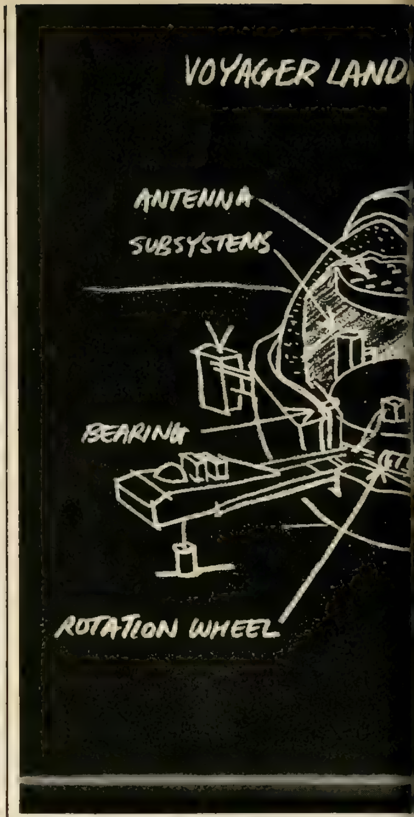

VOYAGER: The Mission.

Interesting world, our neighbor Mars. It's only half the size of our own Earth. Gets around the sun in twice the time we do. Has a thin atmosphere, some moisture, reddish surface, no mountains to speak of. And perhaps some form of plant life. We'd like to know more about Mars. And Venus, too. The highly successful Mariner program has been designed to answer some of our questions. NASA's Voyager is proposed as the next step in the systematic exploration of the planets . . . targeted for the late 1960's.

Still in the study phase, the first Voyager vehicle to probe Mars (and perhaps Venus) would probably be launched by an adaptation of the Advanced Saturn booster currently programmed for Apollo. Designed to land a payload of complex instruments, it would gather a rich harvest of data that can make future manned flights possible by bringing back the answer to the basic question: "Can man land and survive on Mars?"

The Study.

Before the flight, the digging for data. NASA has asked Avco to do a six-month study program to investigate problems inherent in the development of the Voyager project. The answers will point the way for successful fabrication, launching, orbiting, and landing of Voyager vehicles on Mars and Venus.

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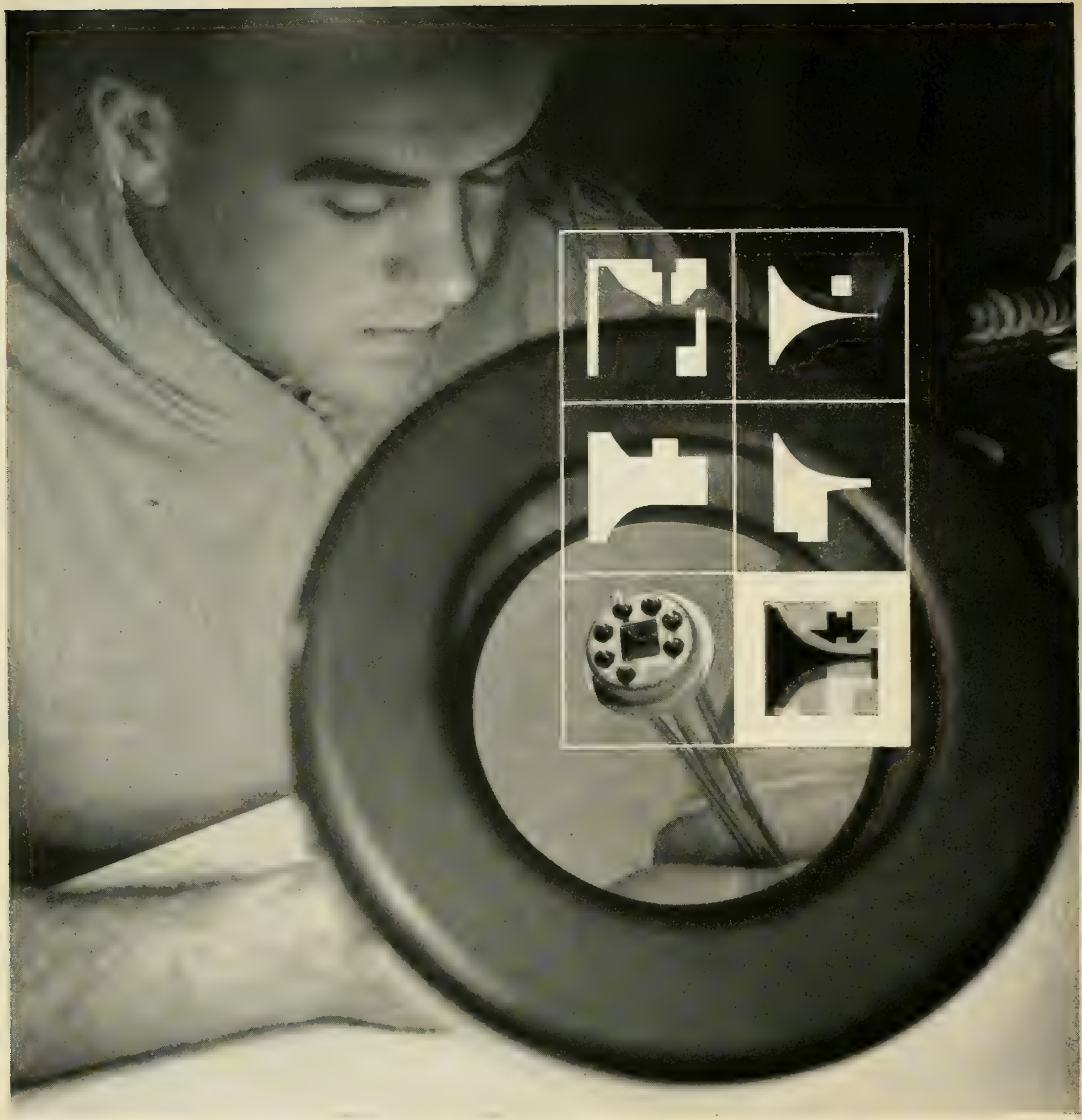


MICROMINIATURE CIRCUITRY...

part of the big world of electronics at Boeing

Microminiature thin-film circuitry research is one of the many advanced areas of electronics activities at Boeing's Aero-Space Division.

Engineers in the Division's electronics techniques organization superimpose a series of film shapes as thin as 1/4,000,000th of an inch, to create a complete electronics network. A microminiature network, measuring 1/10″ square, is shown magnified above, mounted on a header.

Boeing microminiature electronics capabilities include development of circuits on silicon transistor chips, vacuum deposition of thin-films and mathematical analysis of circuits.

In all, more than 5,000 Aero-Space Division employees are engaged in electronics at Boeing, including design and production of ground-support and launch control systems for the Minuteman ICBM and airborne systems for the U. S. Air Force X-20 space glider.

BOEING

AERO-SPACE DIVISION

DOD Performance System Explained

New Contractor Performance Evaluation to afford military source selectors "realistic, defensible" appraisals

by C. W. Borklund *

DEPARTMENT OF DEFENSE Research & Engineering this month launches its new Contractor Performance Evaluation (CPE) system. There is far more to the system than merely providing future source-selection boards a bigger shield to use against Capitol Hill spear throwing.

CPE is just part of a carefully planned and integrated program to improve DOD management of research and development, both in its own shop and in industry.

The system has already been tested in the field, not only by the military but also by NASA, which will use the same system. CPE at the outset will be applied only to contracts that exceed $5 million a year or cost more than a total of $20 million. But this will cover contractor performance on more than $10 billion in DOD funds, and will mean analysis of some 100 contracts initially.

- **Three areas affected**—There are six categories of DOD R&D effort: research; exploratory development; advanced development; management and support; engineering development; and operational system development. CPE will be applied to the latter two. (Fifteen projects in these two categories consume some 40% of military RDT&E money.)

One primary objective of CPE: Create an environment in which a contractor of his own volition will be more realistic, avoid trying to "buy in" on a major development effort. Defense's selfish, and understandable, reason: In the past, unrealistic and optimistic estimates of cost or work to be performed have ended up with overruns by a frightening factor of three.

To keep these projects alive (the big dollar ones in engineering development or operational system development) once meant siphoning dollars away from the other R&D categories, crippling the future to pay for poor management in the present.

CPE is just one of many tools for tightening up Defense R&D management. Among others: The program-definition phase, (PDP) which makes it extremely difficult to hide or overlook things that will have to be done; as part of PDP, the requirement for a summary PERT/COST network, which forces the spelling out in detail of tasks that must be done and how much they will cost; Cost-Plus-Incentive-Fee contracting, which stresses realistic contractor pricing; and for the long haul, CPE will measure and record contractor promises against his achievements for future procurement reference.

- **Absolute, not relative**—DDR&E's Bob Tucker (who has directed a team headed by Army Colonels Stewart P. Blake and Herbert O'Connor in developing CPE) lists among the CPE system's strengths not only those things it will be but some things it will not be. It will be an evaluation report, not a report card. It will rate what a contractor did against what he promised, not rank him against other contractors.

Says Tucker, "We want to generate a report on how well the contractor performed. We don't want to encapsulate this thing, make it possible for the source-selection board to push a button and get a grade out of the computer. (Evaluation information will be computer-stored in the Office of the Secretary of Defense, and will be on call to any source-selection board).

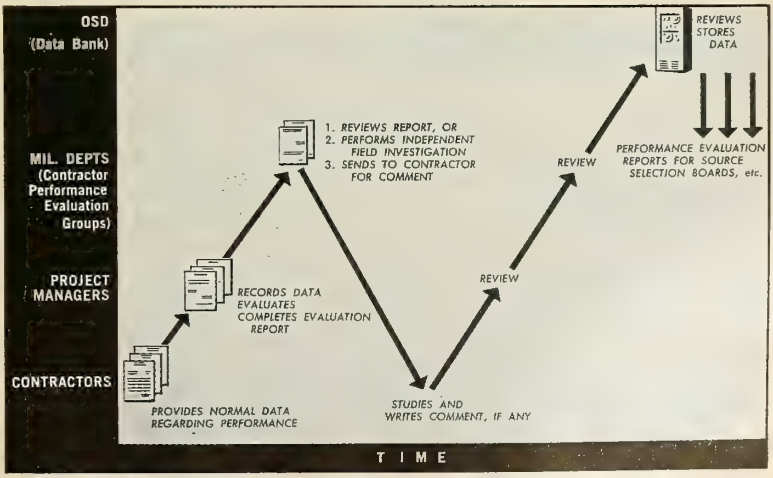
"We want to make available a report that has to be read. After all, with just a rating, a company could have a very high general rating and yet have no experience in the field in which you're about to award him a contract—or on a past contract, [he may] have fallen down on the portion of the contract you're most interested in."

In setting up CPE,, five principles have been followed:

(1) The system is to provide and record high quality, high reliability data on the quality of a contractor's performance in meeting, or attempting to meet, selected, measurable objectives defined by his contract with the government.

It is important to emphasize that the system should *not* be designed to evaluate indicators of a contractor's performance potential, such as his organization, cost-accounting system, facilities, or make-or-buy procedures.

Neither should it render judgments about the quality of the contractor's product in an absolute sense. What it must do is to focus single-mindedly on determining what the contractor's agree-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RECORDS DATA
EVALUATES
COMPLETES EVALUATION REPORT
1. REVIEWS REPORT, OR
2. PERFORMS INDEPENDENT FIELD INVESTIGATION
3. SENDS TO CONTRACTOR FOR COMMENT
STUDIES AND WRITES COMMENT, IF ANY
REVIEW
REVIEW
REVIEWS STORES DATA
PERFORMANCE EVALUATION REPORTS FOR SOURCE SELECTION BOARDS, etc.
TIME

CPE GOES through usual contractor report channels.

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* *Because of its broad industry impact,* Missiles and Rockets *presents a condensed version of this article, which originally appeared in Armed Forces Management magazine. Mr. Borklund is editor and publisher of Armed Forces Management, an American Aviation Publication.*

CPE IN PERSPECTIVE

Setting up Contractor Performance Evaluation has been no flighty, snap-judgment affair. As a result of extensive field testing on the proposed procedure, several questions were raised time after time. Here are the questions, and Defense Research and Engineering's answers:

Q. Can R&D be measured and evaluated?

Yes, to varying degrees. The important point is that the degree to which this can be accomplished increases as one moves from the research to the development end of the R&D spectrum. Evaluation of development work is already quite commonly done.

Q. Will adjective or ordinal ratings be used?

The purpose of the system is to evaluate the factual performance of the contractor against his commitment. Numerical or adjective ratings are not necessary for this purpose. The system is not designed to generalize about contractors by arranging them in an order-of-merit ranking.

Q. Will this system produce a blacklist?

There will be no such list. The file will contain the facts and these facts will be available to those having need for them. If a contractor has a record of consistently poor performance it may hurt his chances of obtaining a particular contract award, but this is in no way different from the intent of the present system.

Q. Can responsibility be sorted out?

Yes it can be, and it is done every day when the contractor and the contracting officer meet to negotiate the costs of contract modifications. There is no doubt that when the stakes are larger there will be increased pressure on the contracting parties to be sure that adequate records are kept to aid in allocating responsibility.

Q. Does the contractor have an input?

Yes, in two places. First, he continues to provide the basic project status information to the project manager. Second, as previously indicated, the reports of the CPEG are forwarded to him (see chart) for comment. His comment becomes part of the performances evaluation report and thus becomes part of the permanent record.

Q. Can a poor record be overcome?

Yes, but certainly not without effort on the part of the contractor. Prior performance is only one factor in source selection. If a contractor has a superior technical approach, a favorable cost proposal, and shows that he has taken action to correct the situations that caused his previous poor performance, there is no reason why he will not have a chance to win in source selection competition. The best time to prove ability to overcome poor performance is during the course of a contract where periodic evaluations will show trends.

Q. Does this system usurp the project manager's perogatives?

No it does not. This system is not designed to manage, but rather to measure and report. It is expected that project managers will avail themselves of the valuable information these reports contain, and there is little doubt that the process of completing these evaluations will focus the attention of the manager on problem areas as they arise.

Q. How big a paper work burden is this going to be?

There is no reason why there should be any substantial increase in the amount of paper work required of the project personnel. Any well managed project will have available the information called for by this system and the burden is merely that of recording it and sending it downward. It will be a burden to projects which are not keeping adequate records now.

Q. Is this increasing government interference in contractors' affairs?

Quite the contrary. This system is intended to provide contractors with an incentive to manage their programs as the government would wish, without the need for close government control. It is hoped that through this medium it may be possible for the government to establish a type of "graded surveillance" whereby consistently good performers will be relieved of some of the close scrutiny to which they are presently subjected.

Q. Does this keep the little fellow out?

No. There is nothing in this program which works to the advantage of the large contractor (or to his disadvantage). By concentrating on the degree of achievement of promised performance, all contractors are placed on an equal footing.

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ment with the government required him to do and how well he satisfied that agreement.

(2) Although sound professional judgment will be required, the system should be fact-oriented to the greatest extent possible to minimize variability of results because of variation in judgment.

(3) The system must emphasize integrity of the evaluation process. Since the fundamental purpose of the system is to reward good performance and penalize poor performance, the evaluation procedure must consistently discriminate between and within these limits.

(4) The system must provide suitable checks within the evaluation process so that no single input can unreasonably affect the total evaluation.

(5) The system must be capable of implementation within the resources available to the government, while providing the required level of quality and reliability.

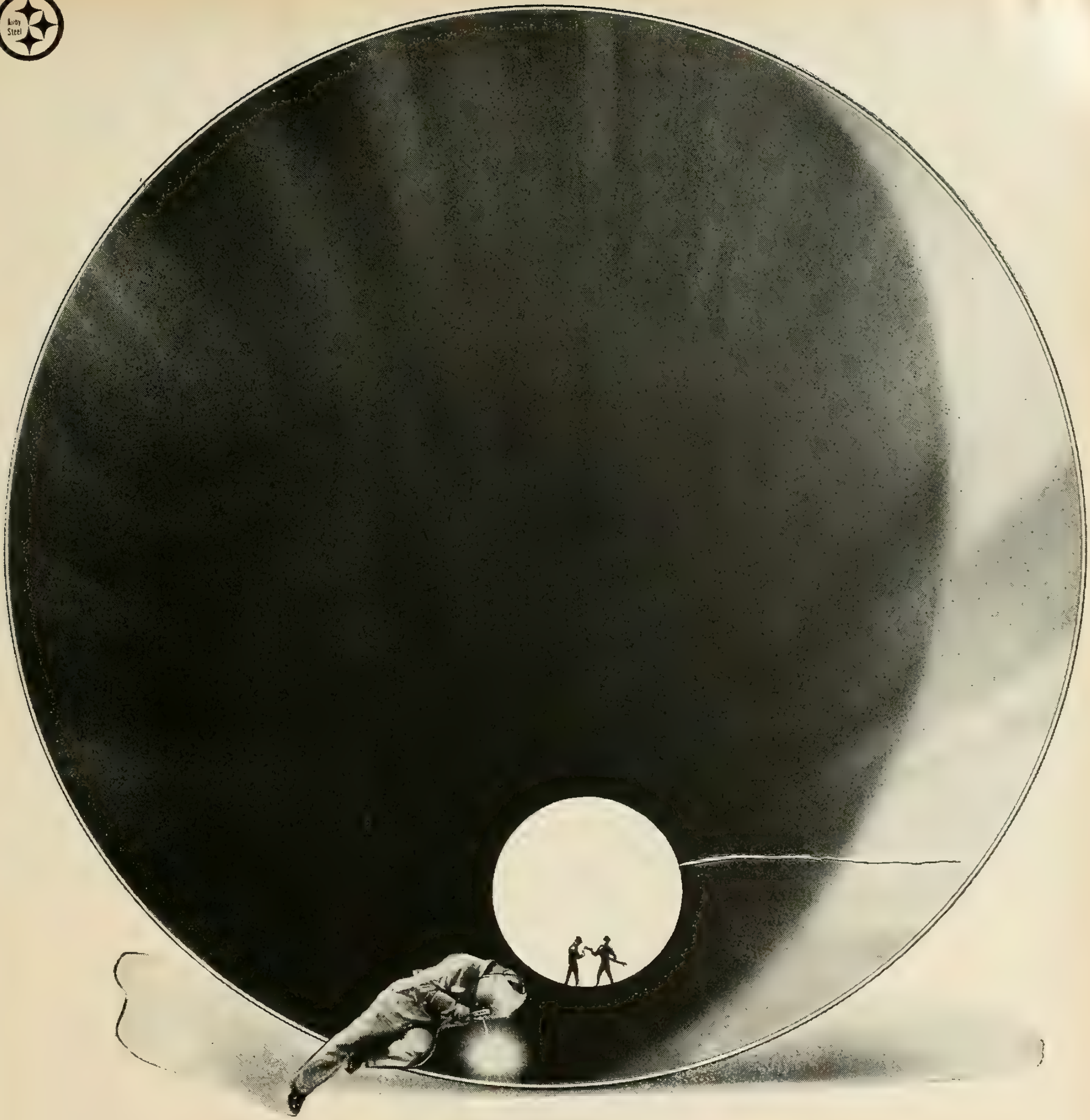
- **Report breakdown**—The evaluation report itself breaks down into four parts: A—cost promises against achievements; B—schedule promises against achievements; C—technical parameter promises against achievements, i.e. performance against specifications; and finally, D—a narrative. The narrative's object will be to clarify data listed on the forms for the first three sections of the report simply because the data forms themselves haven't enough room to tell *why* achievement was above or below promise.

CPE's will be turned out periodically during a contract's duration and at termination. Says Tucker, "We want to measure the contractor's performance against his current agreement. To downgrade him because the original program scope changed as the program developed through no 'fault' of his would be unfair to him (the contractor) and misleading to future contractor selection boards.

"We don't look at the end product or its quality. This depends on a mutual government-industry effort. CPE always will be measuring net performance against a net agreement, not net performance against the initial agreement."

The CPE procedure is initiated through the normal process of contractor providing periodic reports and current information, as he does now, to the Defense project office. The project's manager will perform a first level performance evaluation.

This will be sent to a contractor performance evaluation group (CPEG), established at departmental level under the service secretary. (First estimates indicate Army and Navy CPEGs will require roughly six persons, Air Force 16, based on contracts—19 in Army,



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29 in Navy, 85 in Air Force—likely to be given the CPE treatment.)

The CPEG will either (1) review the report for compliance with CPE's system policy and then forward it to the contractor for comment or, (2) if the group has any questions on the evaluation itself, it may go so far as to perform an independent evaluation in the field.

In the latter case, CPEG's evaluation, along with the project manager's report, will be forwarded to the contractor for comment as well as the report—or reports—and become part of the permanent file.

The contractor returns the reports through the project manager to the CPEG. Both project manager and CPEG take another look, resolve any ambiguities and forward the reports to a Defense Department Contractor Performance Evaluation Office where they are reviewed and placed in a computer data bank to provide easy retrieval by qualified users (contractor selection teams in the services, NASA, et al) on a need-to-know basis.

Key to the effort, indeed a man who will himself indirectly be evaluated in CPE, is the project manager. In field tests, project managers have "produced very meaningful reports with a minimum of instruction," says Col. Blake. The great majority of their questions concerned only the administrative detail.

● **Test results encouraging**—In effect, the extensive field tests have shown the CPE will work, is practical and does not require a substantial amount of extra work.

There will be several fallout benefits from the use of CPE. One will be to add pressure to that which already exists —through program definition phase and similar techniques—for both the government and the contractor to maintain better, more realistic statements of work.

Secondly, CPE will focus the contractor's and project manager's attention on problem areas that might otherwise pass unnoticed. Moreover, CPE will tend to keep the project manager and the contractor on what DOD terms "a desirable arms-length" relationship. "If," cautions one spokesman, "this destroys mutual respect, the whole system is bad. But I don't believe it will, except in those areas where there isn't much mutual respect now anyway."

Finally, CPE will create an atmosphere that will aid the incentive contracting environment, acknowledge both the feasibility and desirability of establishing clearly defined goals and tying awards to accomplishments—at least in engineering and operational systems development programs. ■

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TI, Fairchild Aiming at Circuit Tester Market

by Michael Getler

SAN FRANCISCO—Two leaders in the burgeoning field of integrated circuit manufacture are now vying for what appears to be a limited but lucrative market for universal-type automatic semiconductor integrated-circuit testers.

Texas Instruments and Fairchild Semiconductor recently announced availability of new broad-capability testers with flexible, modular programming to allow growth in handling new IC's. Considerable interest in operating hardware displays was observed at the WESCON meeting held here late last month (M/R, Aug. 26, p. 26).

In general, industry observers expect that the mushrooming number of I-C manufacturers will trigger increased moves toward diversification of product lines by many firms to keep sales figures on the rise despite growing competition.

- **TI System**—The Texas Instruments unit performs go/no-go decisions on semiconductor I-C logic functions and parametric checks with a capability of running through 36 direct-current tests on direct-coupled devices with up to 14 terminals in 1.5 seconds, according to the firm. This corresponds to about 30 milliseconds per test with 10 milliseconds between tests.

The tester makes two-point Kelvin connections, a power lead and measurement lead, to each terminal, TI reports, to eliminate contact resistance errors. Bias conditions are provided by four programmable supplies—two 20-v, 2-amp units, and two 50-v, 0.75-amp units, all with 0.05% regulation. Programming is accomplished by precision resistors on plug-in circuit boards. TI reports it is encouraging customers to do their own board programming, with the firm's aid if requested.

TI engineers also report that the test capacity of the unit can be doubled (to 72 tests) by connecting two units operating in series from a single socket. With a companion sorting device, internal sorting logic can sort the circuits into 16 specific categories (15 operating categories plus reject) based on 36 tests. Front panel lighting indicates tests failed. Go/no-go decisions are made by a comparator with a voltage resolution of 100 picoamps.

The unit's go/no-go operation will be augmented with a read-out capability during the next year and engineers also hope to add ac test capability by the end of this year to a modified system, which would expand IC testing to include some amplifiers and other logic functions that cannot be checked with dc.

Also slated for addition to the unit early next year, according to the firm, is a new solid-circuit-network carrier. This is a small, high-temperature plastic device to which individual circuits are mounted. The carriers are then loaded into magazines, handling 15-20 carriers, for use in large scale testing. The circuits are sheared off after test. The carriers are also designed so that they may be used as easy-to-handle plug-in type building-blocks for breadboard systems.

TI also reports it hopes to introduce an automatic IC test scanner with the carriers for large-quantity testing. A manually loaded package is now used for low volume runs.

The basic TI unit measures 19 x 28 x 20 inches.

- **Fairchild System**—The basic Fairchild unit, larger and more expensive than the TI device, includes capability for data logging, digital readout, and punch-tape drive in addition to automatic sorting and go/no-go checks.

Fairchild representatives told M/R that a development program aimed at adding capacitive-coupled integrated circuit tests to current test capabilities for all direct-coupled devices is nearing completion. Automatic index, scanner and loading devices are also said to be under development.

The Fairchild Series 4000 integrated digital circuits tester is a third generation system, according to the firm, representing more than 2 years development effort and about $400,000 in company investment.

According to Fairchild, the tester can perform 61 tests in 1 second, and can handle circuits with up to 13 leads. The firm also reports it is looking into possibilities for increasing test capacity to 100. The design incorporates 15 power supplies, and what Fairchild describes as "uniquely designed amplifiers yielding ½ millivolt resolution both on milliwatt devices and other types of integrated circuits."

The system, which is also designed to operate in series to increase capacity, incorporates modular plug-in programming set within a removable drawer included in the equipment rack.

According to Fairchild, test conditions for the elements to be tested are programmed by high-stability potentiometers and precision power sources, and are pre-selected for "typical" and "worst case" conditions of input and output specs. The circuit is first tested for functional logic operation, followed, if it is accepted, by two series of 30 and 31, respectively, programmed dc input-output tests. There are 12 programmed "fail" categories within the dc test sequence.

In addition to the basic go/no-go operation, an optional digital readout of test results is provided by a four-digit digital voltmeter which can also be used for system calibration. A data-logging adapter, also optionally available, operates in conjunction with the dvm. A front panel selector can be programmed to data-log each device tested or a selected numerical pattern.

- **Potential market**—TI marketing officers see two wide market potentials, at this point, among semiconductor integrated circuit manufacturers and high-volume users of integrated digital logic circuits such as computer manufacturers.

Fairchild marketing directors, pointing to the extensive data-logging and readout capability in their present system, also expect to place heavy emphasis on use of the device in circuit studies, high-reliability programs and other data-gathering projects. Fairchild officials estimate sales of about $1 million for the Series 4000 next year.

Clouding sales forecasts are uncertainties concerning the state-of-development of systems of this type by other IC manufacturers—either solely for in-house use or with an eye toward making them commercially available. Both TI and Fairchild report their new testers initially grew out of a need to check out their own circuits in-house prior to customer delivery. A canvas of many manufacturers represented at WESCON turned up little evidence that other firms were planning to market comparable universal-type IC test equipment. ■

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2nd Scout Launcher To Speed Research, Training at Wallops

by William Beller

NASA's WALLOPS ISLAND facility, striving to keep up with demands for *Scout* firings by the agency's Space Sciences Office, as well as the Defense Department and Atomic Energy Commission, will have a second launcher operational next month.

The new launcher, similar to one at the Pacific Missile Range (PMR), is expected to increase vastly the *Scout* launching rate at Wallops, possibly bringing it to more than one shot a week. Reason is that the old launcher takes two to three weeks to prepare for a firing while the new system, incorporating a dolly on which the *Scout* is first built up, will take less than a week, a NASA spokesman told MISSILES AND ROCKETS.

The *Scout's* popularity as a launch vehicle is due to its relatively low cost and high reliability. This has led to its additional use as a training device and research tool for foreign nationals—increasing the load on Wallops' facilities.

- **International training tool**—The Italians are currently training on *Scout* gear in preparation for their San Marco project, an investigation of atmospheric structure by means of a satellite launched on an equatorial orbit from a floating pad in the Indian Ocean.

The French, too, will soon be arriving at Wallops for *Scout* training in connection with *FR-1*, an all-French satellite under development to check out the present theory of electromagnetic wave propagation (M/R, June 17, p. 15). Plans call for the *FR-1* to be launched by a *Scout* rocket fired from PMR. The 50-kg (110-lb.) satellite is to be sent on an 800-km (496-mi.) circular polar orbit.

Developed by Chance Vought Astronautics Div., Ling-Temco Vought, Inc., the new launcher is being installed at Wallops under a $1.685-million contract with NASA.

Advantage over the present Wallops launcher is that the *Scout* vehicle is first built up in a horizontal position on a dolly in a shop. It is then rolled out, attached to the launcher itself and erected to a vertical position. Time between roll-out and make-ready for a firing can be less than a week.

On the other hand, on the alternate launcher, the *Scout* must be assembled on site and in a verticle position, a more difficult procedure.

- **LTV's shakedown**—LTV engineers put the launcher structure through a complete operational test last July. A similar test is set for next week at Wallops.

The checkout calls for moving the transporter and rocket under the launcher, loading the 72-ft. rocket onto the launcher and then elevating the launcher and rocket into firing position.

Although the rocket contains no live stages during these checkouts, it is loaded with sand and exceeds by several thousand pounds the 37,000-lb. launch weight of an operational *Scout*.

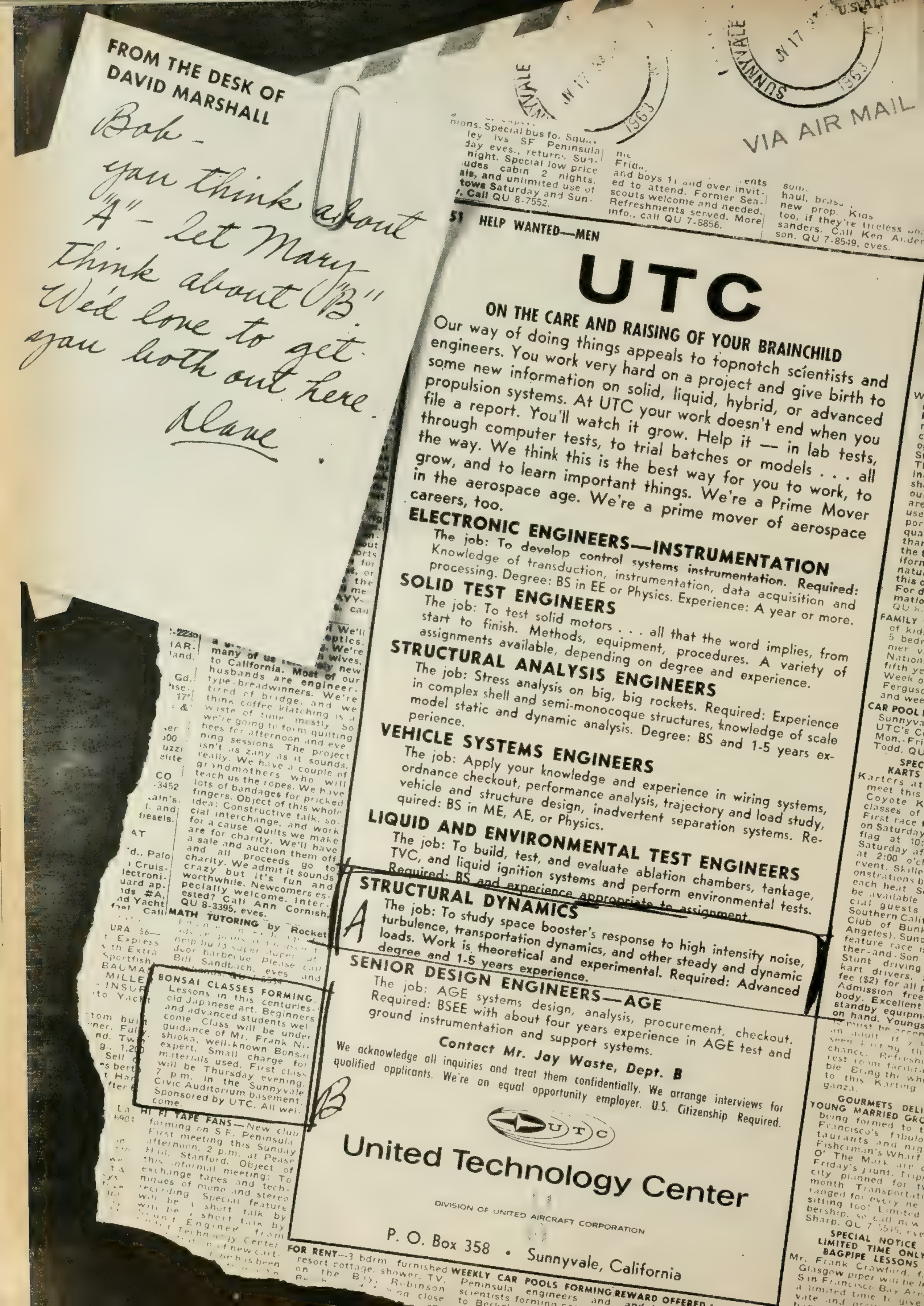
The new-type launcher is 85 ft. high and hinged at the base so that the rocket can be lifted vertically. Pre-launch operations are made with a 70-ft. transporter vehicle and a 120-ft. mobile assembly-and-servicing shelter equipped with heating and air-conditioning.

When the launcher's upper structure is in a "down" position, the shelter, mounted on wheels and rails, can be positioned to cover the entire launcher, rocket and transporter.

- **Design details**—Upper structure of the launcher is positioned vertically by two screw-jacks powered by a 20-hp motor. Several sets of arms, extending forward off the upper structure, support the rocket during lifting operations and before launch. The launcher also can be rotated 140 degrees for precise firing direction.

The *Scout* transporter contains adjustable cradles and carriages that support the vehicle's four stages, permitting assembly and checkout work before the rocket is placed in the launcher. It can be towed by truck for low-speed travel on roads.

The *Scout* was declared operational in the spring of 1962 after an eight-launch development program in which it became the first solid-propellant vehicle ever to place a payload in orbit. Since then, it has lofted a variety of payloads—orbital, high-altitude probe and re-entry—for both NASA and Department of Defense. ■



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... We'll ... eptics. ... We're ... wives, many of us ... new to California. Most of our husbands are engineer-type-breadwinners. We're tired of bridge, and we think coffee klatching is a waste of time mostly. So we're going to form quilting bees for afternoon and evening sessions. The project isn't as zany as it sounds, really. We have a couple of grandmothers who will teach us the ropes. We have lots of bandages for pricked fingers. Object of this whole idea: Constructive talk, social interchange, and work for a cause. Quilts we make are for charity. We'll have a sale and auction them off and all proceeds go to charity. We admit it sounds crazy but it's fun and worthwhile. Newcomers especially welcome. Interested? Call Ann Cornish, QU 8-3395, eves.

MATH TUTORING by Rocket ... help build super duper outdoor barbecue. Please call Bill Sandbach, eves and weekends, QU ...

BONSAI CLASSES FORMING. Lessons in this centuries-old Japanese art. Beginners and advanced students welcome. Class will be under guidance of Mr. Frank Nishioka, well-known Bonsai expert. Small charge for materials used. First class will be Thursday evening, 7 p.m. in the Sunnyvale Civic Auditorium basement. Sponsored by UTC. All welcome.

HI FI TAPE FANS—New club forming on S.F. Peninsula. First meeting this Sunday afternoon, 2 p.m. at Pease Hall, Stanford. Object of this informal meeting: To exchange tapes and techniques of mono and stereo recording. Special feature will be a short talk by ... Engineer from ... Technology Center ...

FOR RENT—3 bdrm furnished resort cottage, shower, TV, on the Bay, Robinson ... close

WEEKLY CAR POOLS FORMING Peninsula engineers and scientists forming ... to Berk...

REWARD OFFERED ...

FAMILY ... of kid... 5 bedr... Nation... fifth ye... Week o... Ferguso... and wee...

CAR POOL ... Sunnyva... UTC's C... Mon.-Fri... Todd, QU ...

SPEC... KARTS ... Karters at... meet this ... Coyote K... classes of ... First race ... on Saturday ... flag at 10... Saturday af... at 2:00 o'cl... event. Skille... onstrations b... each heat. S... be available ... cial guests ... Southern Cali... Club of Bunk... Angeles). Sunc... feature race is... ther-and-Son ... Stunt driving ... kart drivers. ... fee ($2) for all ... Admission free ... body. Excellent ... standby equipm... on hand. Youngs... must be accom... an adult ... chance. Refresh... rest room faciliti... ble. Bring the wh... to this Karting ... ganza.

GOURMETS DELI... YOUNG MARRIED GRO... being formed to ... Francisco's fabulo... taurants and nig... Fisherman's Wharf ... O' The Mark are ... Friday's jaunt. Trip... city planned for ... month. Transportati... ranged for every ne... sitting too! Limited ... bership, so call now ... Sharp, QU 7-5515, eve...

SPECIAL NOTICE LIMITED TIME ONLY BAGPIPE LESSONS Mr. Frank Crawford, ... Glasgow piper will be in ... San Francisco Bay Are... a limited time to give ... vate and ...

The Industry Week

Mergers and Acquisitions

Electric Manufacturing Co., Independence, Kan., has acquired Microlectron, Inc., Santa Monica, Calif., a producer of precision resistive components and packaged networks. Microlectron will be operated as a subsidiary of EMC. EMC manufactures precision metal film and carbon resistors and integrated circuits. . . . *Middlesex Welding Co., Inc., Somerville, Mass., a metal fabricating firm, is being purchased by the Ilikon Corp., Natick, Mass. Middlesex has been a principal supplier of metal shells for Ilikon's ultrahigh vacuum systems for space simulation. Ilikon plans to move the major portion of its space simulation production facilities to the former Middlesex plant. Ilikon is engaged in research and development of new materials and methods and processes of metal fabrication.*

New Firms and Divisions

Orchard-Hays & Co., Inc., is the new name of the Arlington, Va., corporation formerly known as Systems Programming, Inc. The change was made because of the increasing number of companies with similar names entering the computing and data processing fields. Orchard-Hays provides services in the areas of complex linear programming, statistical analysis, mathematical problems and the development of specialized compilers, assemblers and other processors. . . . *The Cubic Corp., San Diego, Calif., has announced the formation of a new Computer Products Dept. The organization will market the Cubic line of data-handling equipment. The company is producing interface, buffer, translation, data-acquisition and data-processing equipment for missile and aircraft tracking complexes. Cubic plans to supply digital systems for use with advanced radars, optical instrumentation, data links and digital computers.* . . . The Boeing Co., Seattle, has organized a market requirements staff to serve as a focal point for market research and requirement information for the company.

International

Control Data Corp., Minneapolis, Minn., has sold its 3600 Computer System to the Institutt for Atomenergi and the Norwegian Defense Research Establishment, both of Kjeller, Norway. The 3600, called the largest and most powerful computer commercially available, can handle 400,000 instructions per second. It will be used by physicists, chemists, and engineers for specialized atomic energy research and nuclear experiments in the Institutt and for a range of applications including ionospheric and geophysical research at the DRE. The two Norwegian firms will pay approximately $1,300,000 for the system. A special educational grant from Control Data is included in the purchase. . . . *Fenn Manufacturing Co., Newington, Conn., producer of swaging machines, has been licensed to manufacture and sell a swaging machine and related accessories developed by Machines ORKA, Zurich Switzerland. Fenn will handle the ORKA product exclusively in the Western Hemisphere.* . . . Boeing Co., Seattle, has licensed British Celanese, a firm in Spondon, Derby, England, to manufacture and sell Boelite, a plastic laminate developed by Boeing. The agreement was negotiated between British Celanese and Applied Technology Co., United Kingdom agents for Boeing. Boelite is now being produced and sold in the U.S. and Japan.

Industry Facilities

Union Carbide Corp., New York City, has announced plans for a million-dollar increase in its facilities for producing highly refined alloys. The expansion is scheduled for completion in early 1964, and will be located at the firm's Stellite Div. in Kokomo, Ind. The new facilities will include a 10,000-lb. capacity induction vacuum melting furnace, a 30-in. consumable electrode vacuum arc furnace and a 20,000-sq.-ft. building to house both units. . . . *Defense Electronics, Inc., has completed a new 10,000-sq.-ft. plant in Rockville, Md. The building includes a quick-reaction facility for short-run equipment lines, a shipping and packing department and assembly facilities. The plant will employ approximately 100 people.* . . . The Physics Research Div. of Geophysics Corp. of America, Bedford, Mass., under contract to NASA, is building new laboratory test equipment designed to simulate the lowest possible pressure conditions which exist in interplanetary space.

Potpourri

Major Lockheed Aircraft Corp. computer centers some 400 miles apart have been linked by new data communications methods. The system ties together, by microwave and by coaxial cable, the full computing capabilities of Lockheed Missiles and Space Co.'s Sunnyvale and Van Nuys branches and its sister California company at Burbank. Joining the computer centers was accomplished through a microwave and coaxial cable link provided by the Pacific Telephone & Telegraph Co. and a General Electric Transmission Data system known as TDS-90. . . . *Midvale-Heppenstall Co., Nicetown, Pa., producer of vacuum-melt metals, heavy forgings and large machined parts, has been granted a patent license by Anocut Engineering Co., Chicago, to produce equipment for electrolytic machining, especially in heavy industrial applications. Equipment will be used for cutoff work, especially on large billets of high-alloy materials; for taking test cores from forgings at various positions; and for producing shapes in large metal components.*

missiles and rockets

SPECIAL REPORT: ADVANCED GUIDANCE AND CONTROL SYSTEMS FOR MISSILES & SPACECRAFT

issue: october 7, 1963 **advertising closing: september 23**

During the next few years designers and manufacturers of advanced guidance and control systems will play a major role in the military's future weapon systems and NASA's manned spaceflight programs.

On October 7, MISSILES AND ROCKETS, The Weekly of Space Systems Engineering, will present a complete report covering advanced guidance and control systems. This special Report will include:

1—Total Market Survey

- **Expenditure Estimates Through 1975**
- **Major Research & Development Trends**
- **Rundown of Major Companies in The Field**

2—Survey of Advanced Guidance & Control Systems

- **Aerospace Plane**
- **Agena-D**
- **Nike X/Sprint**
- **Lance**
- **Mauler**
- **Minuteman**
- **MMRBM**
- **Polaris A-3**
- **Saint**
- **Shrike**
- **Slam**
- **Sidewinder-C**
- **Titan III**
- **Typhon**

3—Advanced NASA Systems

- **Rendezvous Techniques**
- **Gemini**
- **Apollo**
- **Lunar Excursion Module**
- **Lunar Logistics Supply**
- **Titan II Booster**
- **Saturn Booster**
- **Voyager**
- **Mars Vehicle**
- **Manned Orbiting Space Station**

4—Significant R & D Advances in Inertial Guidance Techniques

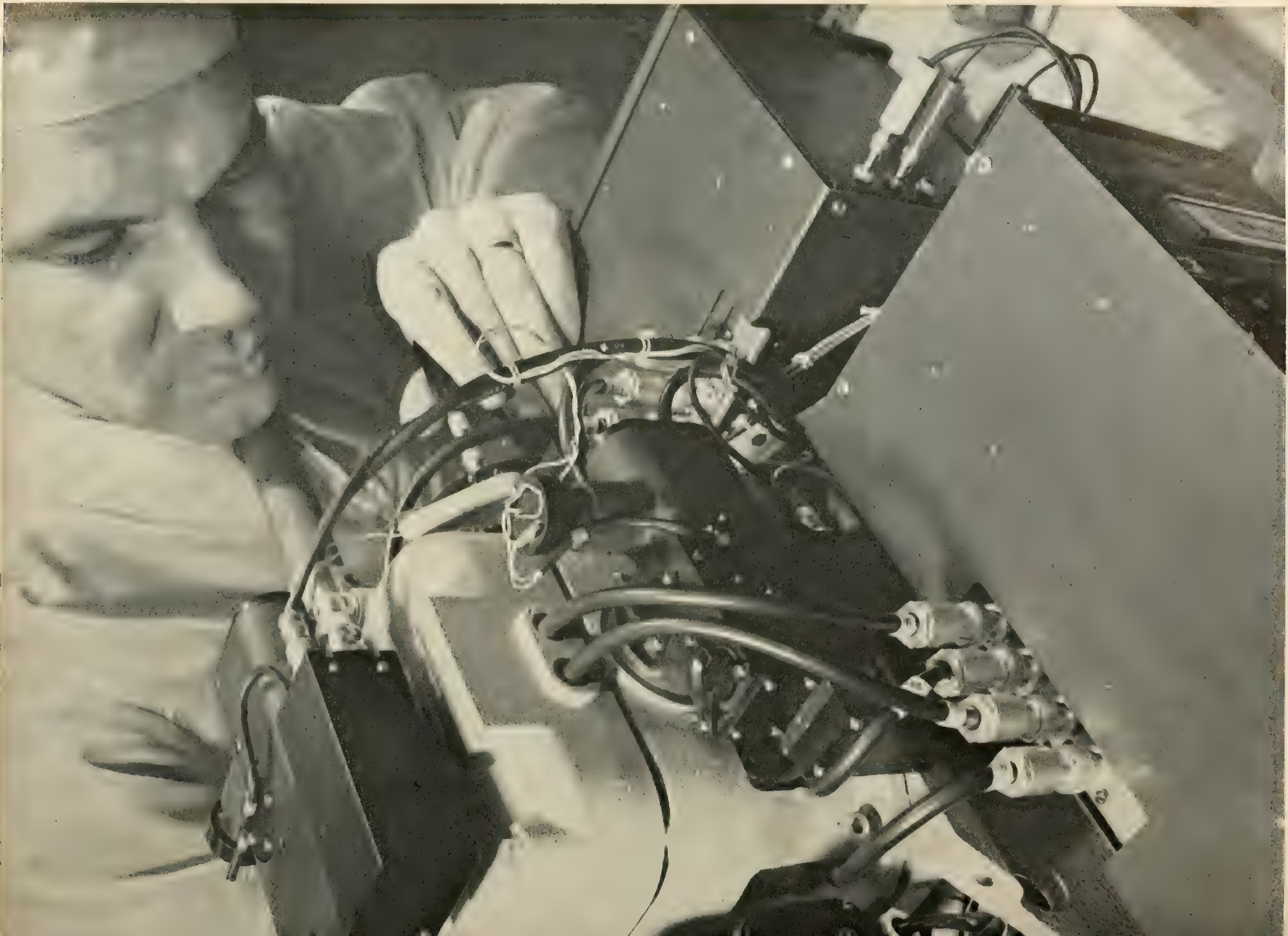
- **Electrostatic Gyros**
- **Laser Gyros**
- **Solid State Gyro**
- **Nuclear Spin Gyros**

5—Complete List of People and Offices Controlling Military & NASA Guidance & Control

MISSILES AND ROCKETS' Special Report will be a prime advertising opportunity for every company engaged in Guidance & Control activities.

Over 43,000 technical management, engineers, scientists, and designers will read of your G & C capabilities and products in this important Special Report on Advanced Guidance & Control Systems for Missiles and Spacecraft.

remember: advertising closes september 23



MULTI-MILLION
DOLLAR
FLORIDA
EXPANSION
CREATES
NEW OPPORTUNITIES
FOR ENGINEERS

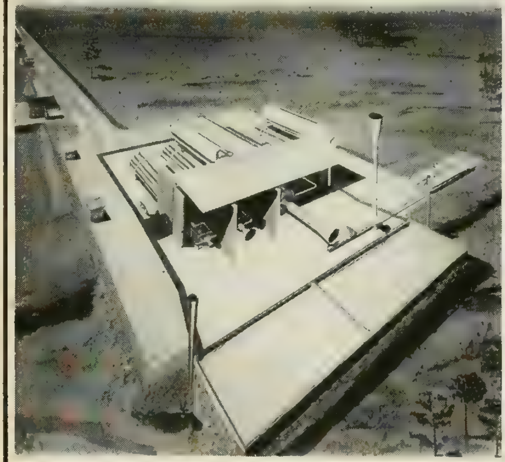
Consistently Pratt & Whitney Aircraft invests in America's future. Latest such investment is a new multi-million dollar firing bay for the Florida Research and Development Center. Here engines with thrust ratings up to 50,000 pounds will be operated on exotic fuels.

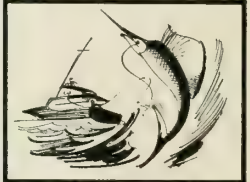
At this 7000 acre Florida center, creative development work is constantly in progress on advanced propulsion systems such as the J-58 and RL-10. The latter was the nation's first successful liquid hydrogen engine and will power both Centaur and Saturn S-IV space vehicles.

Equally important space age projects are in process at Connecticut facilities. These include development work on the propulsion system for the TFX tactical fighter; the fuel cell for Apollo; and the SNAP-50 nuclear reactor for deep space probes.

CHALLENGING ASSIGNMENTS ARE AVAILABLE IN . . .

Thermodynamics
Vehicle Systems Design
Mechanical Design
Fluid Mechanics
Turbojet & Rocket Control Systems
Air-breathing & Rocket Propulsion Concepts Evaluation
Stress Analysis-Vibrations
Experimental Test
Component Development
Instrumentation and Electronics
Heat Transfer





The most advanced rocket engine liquid propellant capability in the United States, this new addition can safely handle all known combinations of liquid propellants including hydrazine, diborane and hydrogen.

Depending on your preference, write either Florida or Connecticut:

FLORIDA
Mr. J. C. Morton
Pratt & Whitney Aircraft
West Palm Beach, Florida

CONNECTICUT
Mr. P. C. Smith
Pratt & Whitney Aircraft
East Hartford 8, Conn.

Pratt & Whitney Aircraft
UNITED AIRCRAFT CORPORATION
An Equal Opportunity Employer

—contracts and procurements—

AWARDS

AIR FORCE

$16,843,199—**Automatic Electronic Sales Corp.,** North Lake, Ill., for production of switching gear for the defense communications system.

$4,200,000—**Raytheon Co.,** Goleta, Calif., for production of airborne electronic reconnaissance receiving equipment.

$3,200,000—**Union Carbide Corp.,** New York City, for research to improve graphite materials for application to aerospace vehicles.

$1,000,000—**Technical Operations Research,** Burlington, Mass., for continued technical assistance to the Air Force Battle Analysis Center for OMEGA (Operations Model Evaluation Group Air Force) including operations research and computer techniques for a study of global air war.

$714,892—**Wolf Research and Development Corp.,** West Concord, Mass., for programming and operation of Spacetrack computers.

$310,000—**Ling-Temco-Vought's Temco Display Systems Plant,** Garland, Tex., for provision of field maintenance for three aerospace defense Iconorama installations.

$250,076—**Perkin-Elmer Corp.,** Norwalk, Conn., for four months' research to determine the design of an optical measurement system to obtain trajectory data during a missile flight's lift-off and early launch phases.

$249,991—**Thiokol Chemical Corp., Wasatch Div.,** Brigham City, Utah, for applied research directed toward design and demonstration of different methods of thrust termination.

$92,317—**General Motors Corp., AC Spark Plug Div.,** Flint, Mich., for spare parts for the *Mace* missile system.

$90,000—**Lockheed Propulsion Co.,** Redlands, Calif., for development, preparation and delivery of solid uncured propellant.

$86,300—**Lockheed Aircraft Co.,** Palo Alto, Calif., for research studies of electrical transmission components for a large aerospace systems environmental chamber.

$82,019—**Honeywell Regulator Co., California Ordnance Center,** West Covina, for research on solar radiation optical systems for a large aerospace systems environmental chamber.

$80,900—**Martin Marietta Corp.,** Baltimore, Md., for spare parts for the *Mace* missile system.

$42,000—**Sperry Rand Corp.,** St. Paul, Minn., for in-service engineering and support of the *Titan I* radio guidance computing system and associated GSE.

Motorola Inc., Semiconductor Products Div., Phoenix, for development of manufacturing methods for surface passivation of integrated circuits (undisclosed amount).

ARMY

$13,117,000—**General Dynamics Corp., Pamona Div.,** Pamona, Calif., for continued research and development of the *Mauler* air defense system.

$10,143,000—**Douglas Aircraft Co.**, Charlotte, N.C., for production of *Nike-Hercules* missile air frames.

$8,588,319—**Sperry Utah Co.**, Salt Lake City, Utah, for engineering services for the *Sergeant* missile system.

$7,000,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for continued development of the *Shillelagh* missile system.

$2,292,233—**Bendix-Friez**, Towson, Md., for production of radiosondes.

$2,012,720—**Northrop Corp., Nortronic Div.**, Anaheim, Calif., for production of *Hawk* missile wing assemblies.

$1,442,595—**Beech Aircraft Co.**, Wichita, Kan., for production of Model 1025 target missiles.

$1,097,167—**Continental Manufacturing Co.**, Garland, Tex., for production of *Hawk* motor parts.

$938,518—**Western Electric Co.**, New York City, for *Nike* missile repair parts (three contracts).

$900,000—**Western Electric Co.**, New York City, for *Nike-Hercules* guidance sections.

$662,420—**Perkin-Elmer Corp.**, Norwalk, Conn., for design, fabrication and checkout of two ground-based optical instrumentation systems.

$635,746—**Martin Marietta Corp.**, Orlando, Fla., for modifications to the *Pershing* missile system.

$500,000—**Ryan Aeronautical Co.**, San Diego, for production of *Firebee* jet targets.

$339,000—**Lear Siegler, Inc.**, Santa Monica, for three service test models of a lightweight gyro-azimuth theodolite.

$308,978—**Raytheon Co.**, Andover, Mass., for *Hawk* missile reconditioning of assemblies, retrofit kits, stabilized magnetron assemblies and repair parts.

$137,515—**Martin Marietta Corp.**, Orlando, Fla., for modification kits for the *Pershing* missile system.

$101,511—**General Electric Co.**, Syracuse, N.Y., for high-power acquisition radar equipment.

$42,459—**Brown Engineering Co., Inc.**, Huntsville, Ala., for Soviet free-flight rocket analysis.

$26,752—**Case Institute of Technology**, Cleveland, for research on control of case grain size of high-strength steel castings under the solid propellant rocket motor materials program.

Emerson Electric Mfg. Co., Electronics and Space Div., St. Louis, for prototype development of a unique rocket system for Army helicopters (undisclosed amount).

Philco Corp., WDL Div., Palo Alto, Calif., for development of an Initial Satellite Communication Control Center (ISACCC) (undisclosed amount).

NAVY

$10,000,000—**Sperry Rand Corp., Sperry Gyroscope Co.**, Great Neck, N.Y., for inertial navigation subsystem equipment for installation in six *Polaris* submarines.

$9,400,000—**Goodyear Aerospace Corp.**, Akron, Ohio, for continued production of *Subroc* missiles.

$4,000,000—**Bendix Corp.**, Mishawaka, Ind., for continued research and development on the *Typhon* missile system.

$1,400,000—**General Electric Co.**, Utica, N.Y., for production of guidance control systems for the *Sidewinder* missile.

$600,000—**Beckman Instruments, Inc.**, Fullerton, Calif., for atmosphere monitoring equipment for the nuclear submarine fleet.

$96,000—**Sanders Associates, Inc.**, Nashua, N.H., for a development program for the application of lasers.

$34,000—**Columbia Scientific Corp.**, Washington, D.C., for 200 radar targets.

NASA

$7,658,000—**Kollsman Instrument Corp.**, New York City, for guidance and navigation equipment for the *Apollo* spacecraft command and service modules.

$5,800,000—**Collins Radio Co.**, Dallas, for provision and installation of electronic systems for four satellite tracking stations.

$228,000—**Geophysics Corp of America**, Bedford, Mass., for an experimental study of the dynamics and structure of the upper atmosphere.

$112,600—**American Machine & Foundry Co., Advanced Products Group**, Stamford, Conn., for fabrication of a hydraulic supply unit for the *Saturn* program.

$72,970—**Avco Corp.**, Tulsa, Okla., for an environmental test chamber.

$61,000—**Graf-Wallace, Inc.**, Boise, Idaho, for a liquid-hydrogen vacuum-jacketed stainless steel piping system.

$50,000—**Lockheed Aircraft Co.**, Burbank, Calif., for an investigation of the effects of ionizing radiation.

$49,677—**Electronic Communications, Inc., Research Div.**, Timonium, Md., for an investigation of a multi-aperture adaptive antenna system for receiving telemetered data from remote space vehicles or satellites.

$40,771—**Electronic Communications, Inc., Research Div.**, Timonium, Md., for development of test equipment to resolve antenna pattern ambiguities.

ARPA

$6,000,000—**Boeing Aircraft Co.**, Seattle, for work on the High-G Boost Experiment (HIBEX) program at the Redstone Arsenal.

$498,300—**University of Colorado**, Boulder, for support of basic research in the Joint Institute for Laboratory Astrophysics (JILA).

INDUSTRY

$1,000,000—**Antenna Systems, Inc.**, Manchester, N.H., from the **Raytheon Co.**, for engineering, design and fabrication of radar reflectors under the FPS-73 program.

$600,000—**Garrett Corp., Garrett AiResearch Div.**, Los Angeles, from **General Motors' AC Spark Plug Div.**, for development of a pressure and thermal control system for use in the *Titan III* standard space launch vehicle.

$300,000—**Singer Co.'s Metrics Div.**, Bridgeport, Conn., from the **Sandia Corp.**, for production of acceleration sensing devices.

$260,000—**Cosmodyne Corp.**, Hawthorne, Calif., from the **Boeing Co.**, for development of a nitrogen purge system for the *X-20 Dyna-Soar* spacecraft.

$176,000—**Inca Engineering Corp.**, Calif., from **Aerojet-General Corp.**, for development and fabrication of a 1.5-million-lb. load cell calibrator for the M-1 engine.

$132,000—**General Electric Co., Instrument Dept.**, West Lynn, Mass., from the **Boeing Co.**, for provision of instruments for measuring temperature and aerodynamics pressure on the *X-20 Dyna-Soar* nose cap.

$100,000—**Cinerama Camera Corp.**, Los Angeles, from **Hercules Powder Co.**, for 16mm cameras, 1,200-ft. magazines and PUPPET (precise universal photographic presentation of elapsed time) automatic timing units.

$27,392—**Minton Lumber Co.**, Gresham, Ore., from **Lockheed-California Co.**, for spruce veneer used in missile nose cones.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Flight Research Center
P.O. Box 273
Edwards, Calif. 93523

Discriminator, switchable, rack mounted, 23-channel—1 each. Bid opening 9-19-63. Contact Mr. Borysko, Bid Officer, Phone: CLifford 8-2111, Ext. 22301. TWX No. 805-281-5055.

National Aeronautics and Space Administration
Procurement Office
Goddard Space Flight Center
Greenbelt, Md.

Computer and peripheral equipment installed at NASA remote sites—11 each. RFP ADT-53. RFP due date 10-1-63. Contact Mr. Everett Besse, Code 248. Area Code 301, Phone: 982-4329.

Secondary Items Branch
Procurement Div.
Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

Control, receiver, Fed. Stock No. 1430-794-9923, Ord. Part No. 9155859—91 each. IFB AMC(Z)-01-021-64-628. Bid opening 10-8-63. Drawings and bid sets available from nearest procurement district.

Procurement Office
White Sands Missile Range, N.M.

Telemetry, FM/FM ground station test and calibration system per WSMR Cen. Dep. No. 305 and addendum No. 1—1 each. RFP-Q-AMC(R)-29-040-64-31. RFP duc date 9-30-63.

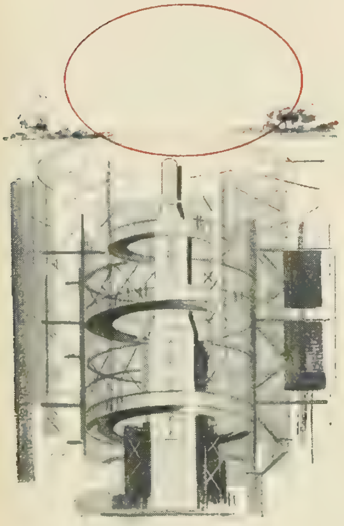
Purchasing and Contracting Officer
U.S. Army Missile Support Command
Redstone Arsenal, Ala.

NASA communication system—IFB No. AMC(Z)-01-021-64-42. Bids, drawings and specs on file at Redstone Arsenal Purchasing and Contracting Div., Bldg. T-3152. Bid opening 10-3-63.

General Support Div.
Directorate of Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

Components, test sets, final assembly and checkout for the Redeye missile system. Destinations to be furnished. Duplication of initial investment in spacial tooling and facilities, requirement for specialized experience necessary to assure system compatibility plus nonavailability of adequate drawings and specs precludes award to other than the prime contractor, General Dynamics/Pomona, Pomona, Calif. All inquiries relative to subcontracting should be referred to the above firm.

UNDERGROUND CORROSION PROBLEMS?



Moisture and condensation causing corrosion problems on steel railings, stairs, diamond plate decking? Rust-Oleum research has developed *specialized* coatings to help you solve these problems. Rust-Oleum specialists are available to work hand-in-hand with you and your organization. May we hear from you?

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Haarlem, The Netherlands

Over forty years of industry proof.
Distinctive as your own fingerprint.

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Circle No. 15 on Subscriber Service Card

New Product of the Week: Optical Analog Computer

The Conductron Corp. is marketing a model C-100 Optical Correlator that offers such linear operations as frequency analysis, filtering, auto-correlation, cross-correlation and a variety of transform-type operations such as convolution and Fourier.

Input data are prepared on a photographic film through which a collimated beam of light is passed, the resulting light wave being modulated to represent the single-channel or multi-channel, one-dimensional or two-dimensional signal. This varying light passes through lenses which perform the desired mathematical operations, the output of which appears on another photographic film. Monitoring of the operation may be accomplished in real time.

Circle No. 225 on Subscriber Service Card

Electron Gun

An electron gun that eliminates the contamination problem in thin film deposition has been developed by the Vacuum Products Div. of Varian Associates.

The unit is designed so that the gun and filament are hidden from the evaporant and substrate. This prevents shorting and arcing from coating build-up on the filament, resulting in high purity films and long filament life.

The gun measures approximately 1¾ x 1½ x 2½ in. and is designed for use in any high vacuum evaporator. It features vacuum-brazed construction, is bakeable to 250°C and has a large evaporant capacity to allow multiple runs without changing evaporant. The focused electron beam gun operates from a 2-kva single knob control unit. A powerful magnet bends the electron stream through more than 180° to heat the evaporant.

Circle No. 226 on Subscriber Service Card

Balanced Valve

A four-way valve, offering a 50 to 70% reduction in pressure drop over previous models, reduced actuation requirements, continuous operation under extreme shock conditions and a 50% reduction in size and weight, is now available from the Hydrasearch Co. Sizes range from ¼ to 1½ in. with servo accuracy.

The device, named the Hydravalve, can be furnished with critical components made from ceramics, carbides, nitralloy or tool steel. It can be used with any system pressure and can be tailored to provide any desired characteristic or programming of flow.

Circle No. 227 on Subscriber Service Card

Voltage Calibrator

A precision voltage calibrator with resolution of accuracy equal to the scope on which it is mounted is available from Horex Electronics Co. The Model B provides fully enclosed calibration controls and an interlock safety feature.

With two inputs, selection is controlled by a switch and each input has a separately adjustable voltage level which permits the study of two waveforms simultaneously. Six separately adjustable levels are provided.

The device has an accuracy of 0.25% over full operating ranges of 1 and 10v with long-term stability of 0.1% per month, and digital dial readout in a 6 x 5 x 4-in. package.

Circle No. 228 on Subscriber Service Card

Underwater Amplifier

A high power amplifier specifically designed for underwater transmissions has been developed by Tel-Instrument Electronics Corp.

The type 14084 provides 6 kva output at frequencies from 100 cps to 5,000 cps into impedances ranging from 160 to 1,600 ohm sizes. Distortion is less than 2%, voltage regulation is adjustable to zero. Output configuration is center-tapped and floating; it can be grounded at either end or at the center tap. The unit incorporates a line voltage regulator that permits operation with line voltage variations from 184 to 276 v ac single phase.

Circle No. 229 on Subscriber Service Card

Opto-Electronic Controls

A series of Raysistor opto-electronic controls designed for use with either dip-solder assemblies or sockets has been developed by Raytheon Co.'s Industrial Components Div.

The CK1121, CK1122 and CK1123 are designed for use in a variety of electronic control functions requiring noise-free operation with either ac or dc signals. Employing an internal light source and a light-dependent resistor, they operate without wiper or contact chatter or switching transients. Typical applications include solid-state variable resistor, switch, dry-circuit relay, circuit isolator, AGC decoupler and voltage and power amplifier.

Dissipation is rated at 100 milliwatts with the maximum potential rating of 200 volts.

The LDR unit is ohmic over very wide ranges of applied voltage and illumination. Depending upon the model, minimum-to-maximum resistance ranges of one million and greater are available, while typical switching times can be obtained from 4 to 30 milliseconds for "on" and 225 to 300 milliseconds for "off." Shunt capacitance has been reduced to 2 pf.

Circle No. 230 on Subscriber Service Card

Decade Exciter

An exciter for use as the master oscillator in either radio transmitters or receivers is available from Rohde & Schwarz.

The Type No. 262 operates on the frequency synthesizer principle and provides an output adjustable in three decadic switches from 0.1 to 30 mc. An interpolation oscillator with a range from 0.0 to 11 kc supplies the intermediate frequencies, and inputs are provided for both amplitude and frequency modulation of the output of the exciter.

Circle No. 231 on Subscriber Service Card

CHEMISTS
CHEMICAL ENGINEERS
PHYSICISTS

Challenging positions are available for appropriately qualified engineers and scientists in an expanding research activity at TEI in suburban Richmond, Virginia, in the following areas:

MATERIALS RESEARCH
Physical chemists, Inorganic Chemists, Chemical Engineers or Physicists, to engage in basic and applied research on high temperature fibrous materials for space applications. Interest or experience in any of the following fields desirable: thermodynamics, kinetics, microstructure of solids, reinforced composite structures.

PROCESS DEVELOPMENT
Chemical Engineers to assist in development of a pilot plant for producing a novel high temperature fibrous material by a chemical process.

BACKGROUND
Bachelors, Masters, or Doctors degrees. All levels of experience.

Inquiries and résumés should be addressed to Mr. H. G. Brinckerhoff.

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EXPERIMENT INCORPORATED**
RICHMOND 2, VIRGINIA
an equal opportunity employer

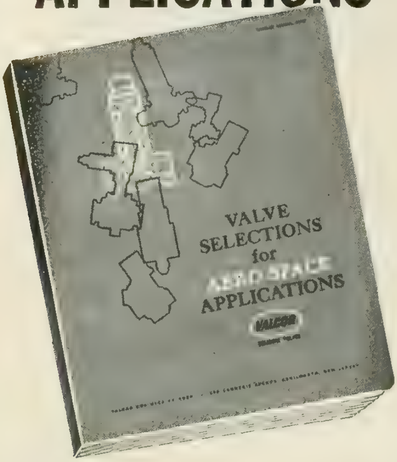
WORLD'S FIRST
AIR TRANSPORTABLE
NUCLEAR POWER PLANT

Martin's PM-1, delivering 1000 kw to a radar tracking station, has been operated by Air Force personnel since November, 1962. For advanced nuclear capability, look to

MARTIN MARTIN MARIETTA

Circle No. 16 on Subscriber Service Card

VALVE SELECTIONS FOR AERO-SPACE APPLICATIONS



A Comprehensive Handbook for users of Aero-space Solenoid Valves!

If you use solenoid valves, you should have this new 56-page handbook by VALCOR, America's most advanced designer of valves for the aero-space industry. It's complete with • Valve data and specifications • Application information • Schematics for layouts • Dimensions • Flow ratings • Applicable Mil Specs • Flow nomographs for gases and liquids.

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Octave Band Analyzer

B & K Instruments, Inc., has available a Model 2112 1/3 and 1/1 Octave Band Analyzer. Designed for analysis and linear measurements in acoustical, electro-acoustical, electronic and vibration investigation, the unit gives 1/3-octave band (1/10 decade) analysis and provides full-octave analysis, accurate to within ±0.5 db throughout the frequency spectrum of 22 to 45,000 cps.

The instrument features contiguous filtering and provides data in terms of 33 standardized frequency bands for optimum signal identification and speed. Specifications: MIL-E-22843 and MIL-STD-740.

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Thermoelectric Cascade

For low temperature evaluation of infra-red detectors, thermistor or semi-conductors, Frigitronics, Inc., has made available an instrumented thermoelectric cascade capable of surface temperatures of —100°C.

The device will handle in excess of 200 mw with less than 8°C loss (Derating value of 0.035°C/mw.)

A #40 copper-constantan thermocouple measures temperatures of the work stage. Sealed terminals plus a silicone '0' ring in the base allows the unit to operate in vacuums of 10^{-6} torr. The unit is water-cooled. A variable temperature power supply (optional) can be used to obtain temperatures from 100° to —100°C.

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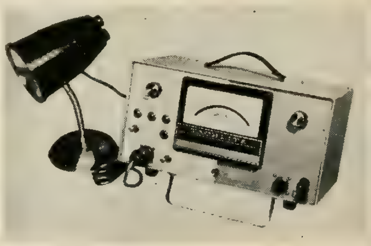

Touchless speed readings and strobe effect from 100 to 120,000 rpm with 1% accuracy are provided with the Power Instruments, Inc., Model No. 830 Tachlite.

Speed is given in five ranges: 1,200; 2,400; 12,000; 24,000 and 120,000 rpm on a Weston Taut Band Meter. Xenon tube strobe operation is to 12,000 rpm direct and through a divider circuit flashes every second revolution on 24,000 and every tenth on 120,000 rpm scales. In this way, tube brightness is retained for daylight operation in motion and vibration analysis. Oscillator control (optional) provides near-sync strobe effect for "slow motion" studies. The tachometry is all solid-state. The input amplifier operates on any voltage from 0.015 to 15v peak-to-peak.

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Precision Voltmeter

Calibration Standards Corp., a subsidiary of Royal Industries, Inc., is marketing the continuously self-calibrating (60 times per second) Precision Voltmeter. Model DC-150B/BR has an accuracy of ±0.1% ±5 microvolts over the complete range of 0 to 1,000v dc.

The portable and all-transistorized instrument has temperature stability of ±7ppm/°C over an ambient operating temperature range of 10° to 40°C. Input resistance, infinite from 0 to 10v dc, 2 meg-ohms from 10v to 1kv, and 5 digit read-out are included.

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Velocity Instrument

A velocity instrument, the VM-4, has been developed by MHD Research, Inc. Originally introduced for passive measurement of luminous hypersonic flows with velocities from 2,000 to 50,000 feet per second, the unit offers a simplified readout and improved accuracy.

Its applications include velocity measurements of rocket exhausts, electric propulsion specific impulse, high speed gyro rotation measurements, ultra high speed mirror and streak camera calibration.

The VM-4 V-Meter consists of a collimated transducer assembly, high voltage power supply, spark injector system and electronic readout unit.

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Columbia Technical Corp. has available a conformal polyurethane coating, HumiSeal Type 2A59, for sub-zero temperature applications. The range of continuous-use temperature is —100° to 250°F.

The device has resistance to chemical solvents, moisture, and weathering and protects glass components subjected to severe environmental conditions. Used on high-frequency coils, it protects against the solid encapsulant resins.

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Marconi Instruments has available a fully transistorized A.F. signal source, Model 2000. Distortion is less than 0.05% from 63 cps to 6.3 kc and less than 0.1% from 20 cps to 20 kc. The device is designed for use on ultra-low distortion telephone and audio circuits.

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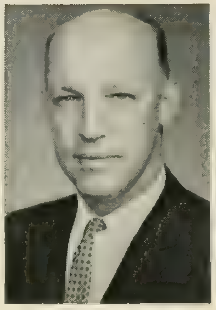
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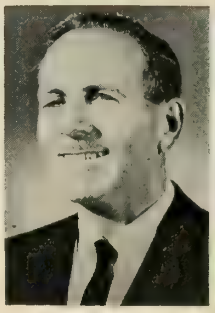
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Lt. Col. Claude D. Helsel (USAF Ret.): Appointed director of branch operations for Bausch & Lomb Inc., Rochester, N.Y.

Robert E. Broderick: Appointed marketing manager of Texas Instruments Inc.'s Industrial Products Group, Houston.

William Duncan: Appointed Washington, D.C. district manager of the Atomic, Defense and Space Group of Westinghouse Electric Co.

James H. Carpenter: Appointed manufacturing engineering manager of the Panelyte Industrial Div. of Thiokol Chemical Corp., Trenton, N.J.

Harry G. Turner: Appointed manager of manufacturing operations for the Motorola Solid States Systems Div. of Motorola Inc., Phoenix.

Paul Hubay: Appointed marketing manager for the Aircraft/Industrial Div. of Adams Rite Manufacturing Co., Glendale, Calif.

Lindsay Russell: Named senior project engineer at Aerospace Research, Inc., Boston.

Harold F. Osborn: Named vice president-marketing for Straza Industries, El Cajon, Calif.

Karl G. Harr, Jr.: President of Aerospace Industries Association of America, Inc., elected to the board of directors of the Union Trust Co., Washington, D.C.

Stanley J. Kukawka: Appointed director of quality control for the Trimpot Div. of Bourns, Inc., Riverside, Calif.

Mark K. Miller: Named manager of the Boeing Co.'s Pacific Test Center, Vandenberg AFB, Calif.

Dr. Richard F. Hoglund: Appointed director of Purdue University's aerospace science laboratories, Lafayette, Ind.

Meyer Leifer: Named vice president-operations at Radiation at Stanford, Palo Alto, Calif.

S. M. Chesler: Named manager of requirements research for aerospace systems at General Dynamics/Electronics, San Diego. **R. A. Glaeser** named manager of requirements research for tactical and marine systems.

D. L. Jeffers: Named purchasing agent, major subcontracting, at the Solid Rocket Div. of Rocketdyne Div. of North American Aviation, Inc., McGregor, Tex.

Dennis E. Ivy: Named director of public relations at Skil Corp., Chicago.

Dr. Newman W. Thibault: Appointed director of research and development responsible for activities at Norton Co.'s Worcester, Mass., and Chippawa, Ontario, research facilities.

Guy W. Fiske: Appointed manager-marketing for General Electric's Electronic Specialty Capacitor Operation, Irmo, S.C.

Girard T. Smith: Appointed director of the organization and systems planning department for Atlas Chemical Industries, Inc., Wilmington, Del.

Fred B. Cox, Jr.: Appointed to head development of telemetry marketing programs for the Systems Div. of Beckman Instruments, Inc., Fullerton, Calif.

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American University, Institute of Electronic Informations Display Systems, International Inn, Washington, D.C., Sept. 16-20.

Institute of the Aerospace Sciences, Antisubmarine Warfare Meeting, San Diego, Calif., Sept. 16-18.

Industrial Electronics Conference, sponsored by AIEE, IRE and ISA, Michigan State University, East Lansing, Mich., Sept. 18-19.

IEEE Annual Conference on Communications, Cedar Rapids Section, Hotel Roosevelt, Cedar Rapids, Iowa, Sept. 20-21.

National Power Conference, sponsored by ASME, AIEE and IRE, Netherlands-Hilton Hotel, Cincinnati, Sept. 22-25.

International Telemetering Conference, Hilton Hotel, London, Sept. 23-27.

Aeroelastic and Dynamic Modeling Technology Symposium, sponsored by AF Systems Command's Aeronautical Systems Div. and the AIA, Biltmore-Hilton Hotel, Dayton, Ohio, Sept. 23-25.

Second Annual Symposium on the Physics of Failure in Electronics, sponsored by the Rome Air Development Center and I.I.T. Research Institute, Chicago, Sept. 25-26.

XIVth International Astronautical Congress, International Astronautical Federation, Paris, Sept. 26-Oct. 1.

IRE Canadian Electronics Conference, Toronto, Sept. 30-Oct. 1.

AIAA Meeting on Engineering Problems of Manned Interplanetary Exploration, Cabana Motor Hotel, Palo Alto, Calif., Sept. 30-Oct. 1.

OCTOBER

Eighth National Symposium on Space Electronics, Institute of Electrical and Electronics Engineers, Fontainebleau Hotel, Miami Beach, Fla., Oct. 1-3.

AIEE Fall General Meeting, Pick-Congress Hotel, Chicago, Oct. 6-11.

IRE National Communications Symposium, Hotel Utica, Utica, N.Y., Oct. 7-9.

Corrosion of Military Equipment Committee, National Assn. of Corrosion Engineers, Admiral Semmes Hotel, Mobile, Ala., Oct. 8-9.

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editorial . . .

A Question of Survival

THE ARTICLE on p. 14 of this issue probably is the most important published by this magazine since its founding. It brings out into the open the critical and highly classified problem which has been at the heart of the opposition to the nuclear test ban treaty by many nuclear scientists and high-ranking Air Force officers. The fact is that the Soviets may have found the answer to their anti-ballistic missile problem by attaining the ability to render U.S. missiles inoperational in their silos.

The possibility is more than a threat to the effectiveness of U.S. missile forces. If true, it threatens to negate the whole deterrent posture of this nation by making possible enemy de-activation of the heart of U.S. nuclear strength.

Since the end of World War II, a strong factor in preventing a nuclear war has been the ability of the United States to overwhelmingly and inevitably retaliate to a nuclear attack with an attack that would destroy the aggressor. This is the so-called second-strike capability, the ability to absorb the punishment of the enemy's first strike and still retain sufficient strength to destroy him.

We have conceded the first strike to our enemies and foresworn it for ourselves. With this in mind, it is clear that the Soviet path to an effective anti-ballistic system is simpler than that of the U.S. If the Soviets can destroy U.S. missiles before they are launched, they have achieved the most effective possible ABM. The U.S., on the other hand, having conceded the first strike to the enemy, must solve an extremely difficult problem—how to knock down incoming Soviet warheads with a terminal system that has assurance of high effectiveness at an acceptable cost.

While seeking the technical solution to this incredibly complex problem, we made the task of the Russians more difficult by burying U.S. land-based missiles underground. This protection of the majority of our ICBM force in hardened silos increased the chances of survival to a point where it was estimated that at least three Soviet missiles would have to be employed against each *Atlas*, *Titan* or *Minuteman* silo to attain a reasonable chance of destroying it. Since this put an impossible burden on the Soviets, the U.S. land-based deterrent missile force was secure.

It now appears that the Soviet Union, as a result of its 1961-62 high-yield nuclear tests, may be developing an ABM system that can wipe out the electronic brains of U.S. missiles with extremely powerful electromagnetic pulses which would leave them inert and useless in their silos.

When asked about the effect of such a Soviet ABM system, Gen. Thomas S. Power, commander of the Strategic Air Command, told the Senate's Preparedness Investigating Subcommittee in a classified session: "I would say this would be a tremendous advantage to the Soviet Union and a tremendous disadvantage to us, again depending on what they have found out."

Gen. Power emphasized that we are not certain that this is what the Soviets are doing or that it can be done. There is good intelligence data to indicate this is what they are attempting to accomplish. A test ban will cut off any possibility of the U.S. carrying out high-yield nuclear tests to discover what is and is not practical—tests Gen. Power believes we should conduct.

As the head of SAC, Gen. Power is in a unique position to judge the degrading effect of such a development on the U.S. nuclear deterrent force. If the development is feasible, we also would want to employ our offensive missiles as an ABM system.

We are publishing this article now because we believe that a subject of such importance should be placed before the U.S. people and openly debated by the U.S. Senate in reaching its decision on ratification of the test ban treaty.

The possibility of Soviet development of such an ABM system based on high-yield testing that the U.S. has not matched is not in itself a reason for rejection of the treaty. There are alternatives that may be acceptable risks, such as increased procurement of *Polaris* submarines and development of advanced manned bombers such as the missile-carrying MPLE (multi purpose long endurance) aircraft or the LAMP (low-altitude manned penetration) aircraft. There is the possibility of "hardening" and shielding missile electronics against EMP just as we have protected the missiles themselves against heat and blast. We may yet develop an early warning system that will allow sufficient time to launch our missiles before Soviet warheads arrive. These measures will take time against an unknown pace of Soviet development.

POLITICALLY, the Soviet ABM development could force the U.S. to a first-strike posture, a dangerous position to which a nuclear test ban might be a much more suitable alternative.

These are a few of the important alternatives which should be considered by the full Senate, not just by the Administration. We are aware that the subject discussed in the article and on this page is one of the highest national classification.

There is no justification for such a security classification. The Soviets have carried out tests on the electromagnetic pulse phenomena of high-yield weapons and know that we have not. They also are acquainted with the possibilities of its ultimate application. There should be no attempt to hide this critical development behind a security screen in an effort to smooth passage of the treaty.

We believe the Senate, before being pressed headlong into an agreement that contains such extensive concealed military implications, should have the opportunity to openly debate these aspects of a treaty, which, as Gen. Power testified, may not be "in the best interests of the United States."

William J. Coughlin

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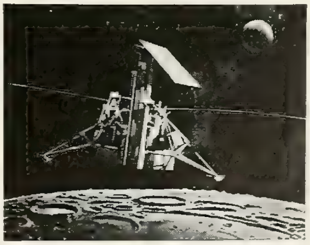

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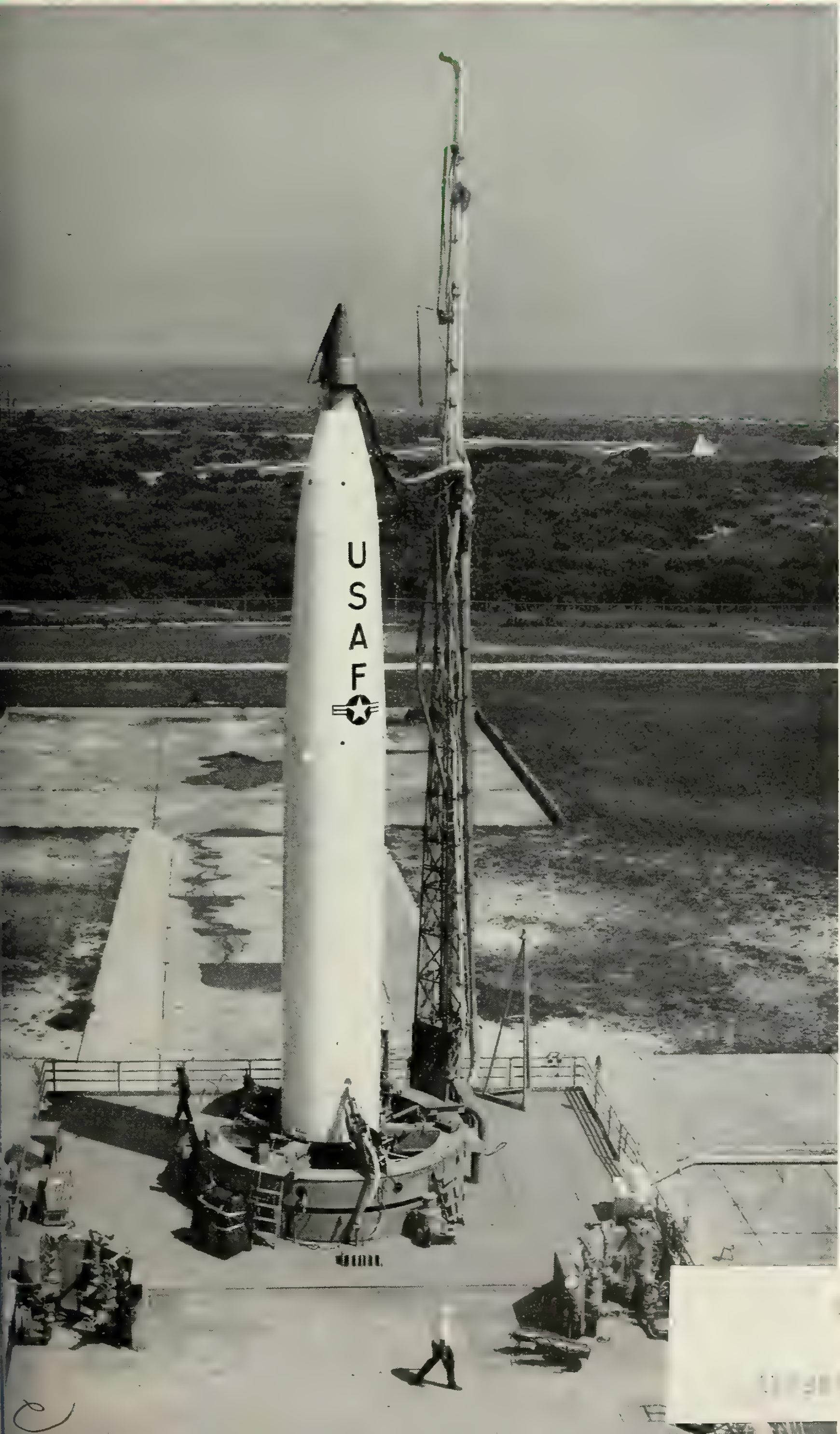

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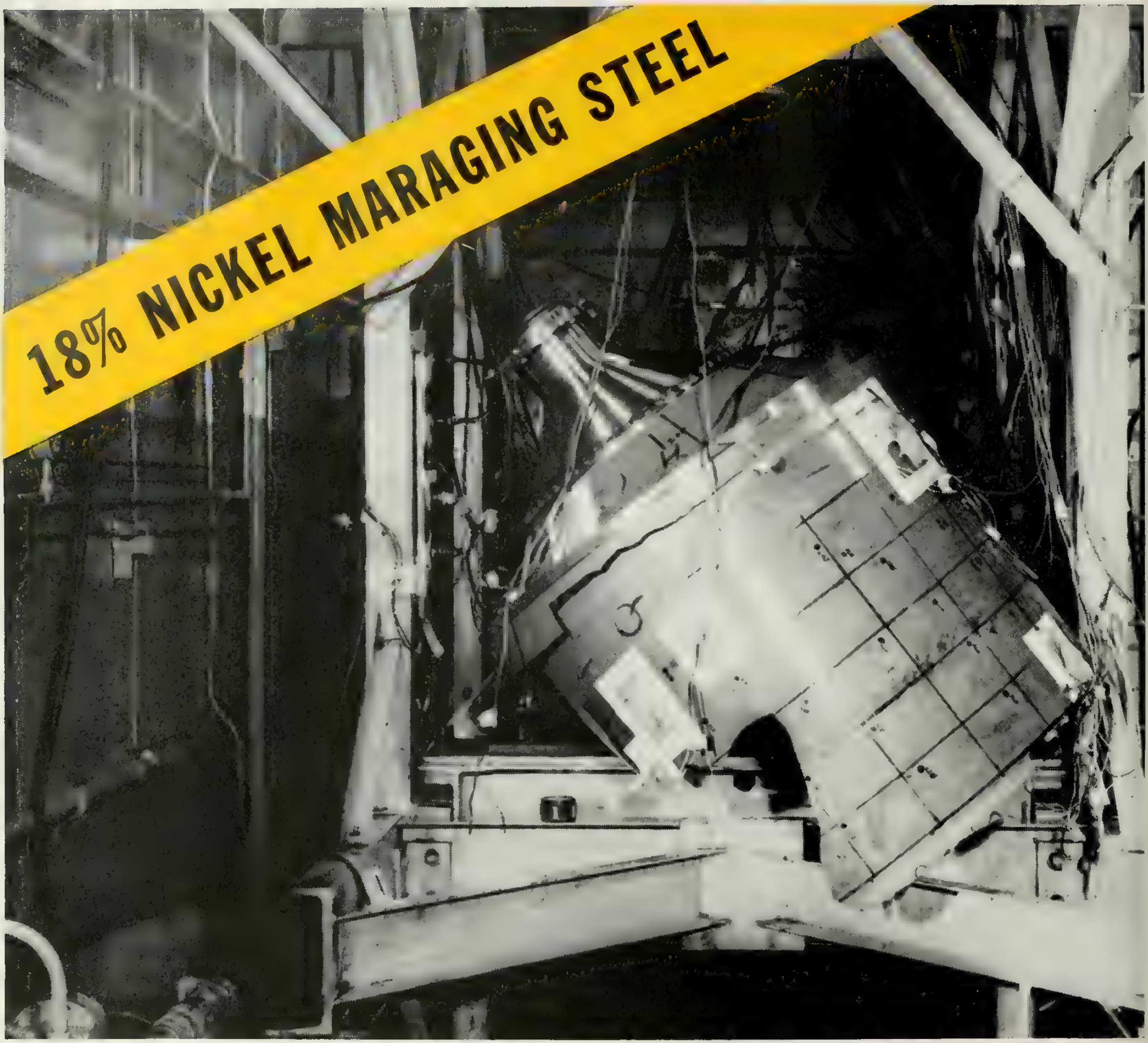

BURST TEST PROVES SUPERIOR STRENGTH OF 18% NICKEL FOR ROCKET MOTOR CASES

Standard's capabilities in producing flawless 18% Nickel maraging steel preforms were recently proved in a materials evaluation program conducted by the Wright Aeronautical Division of Curtiss-Wright Corporation.

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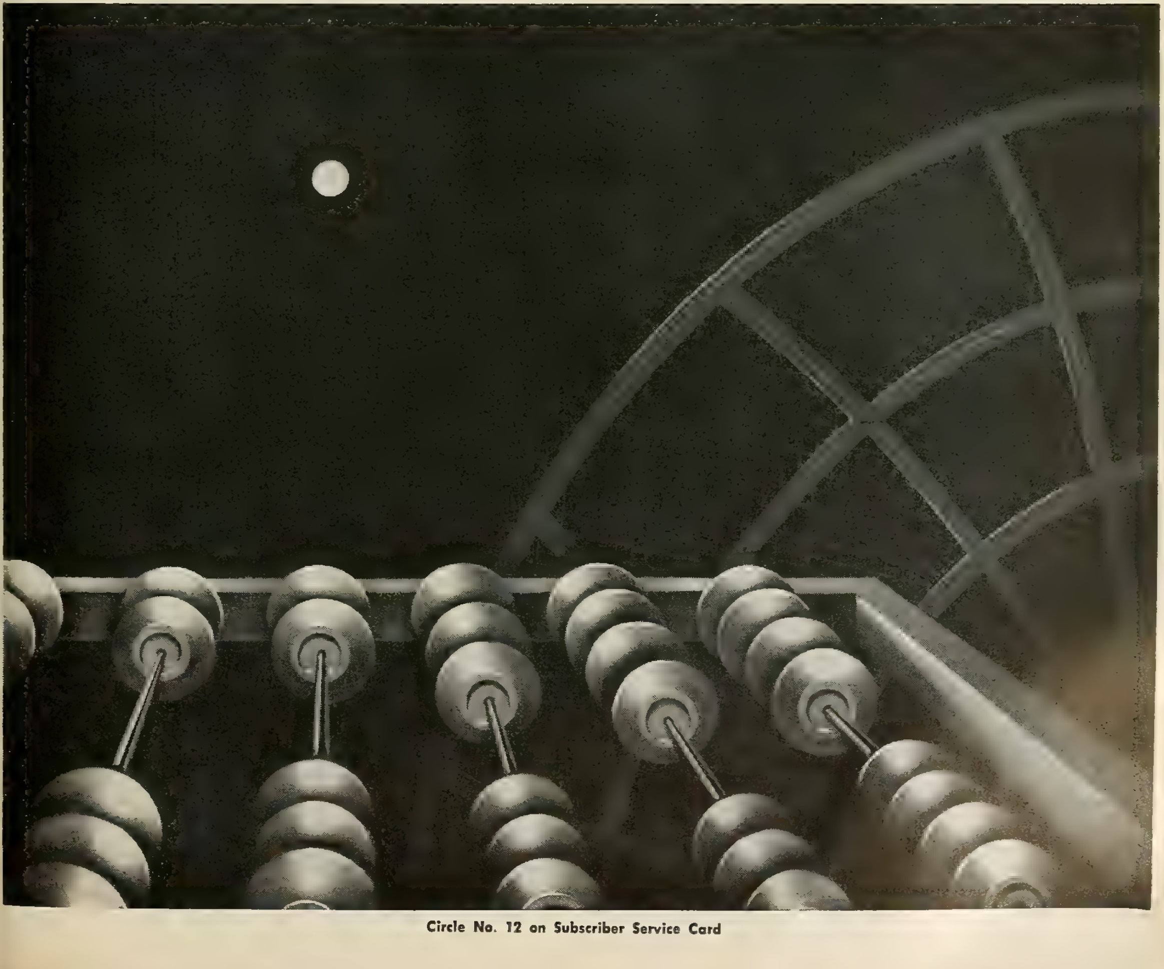

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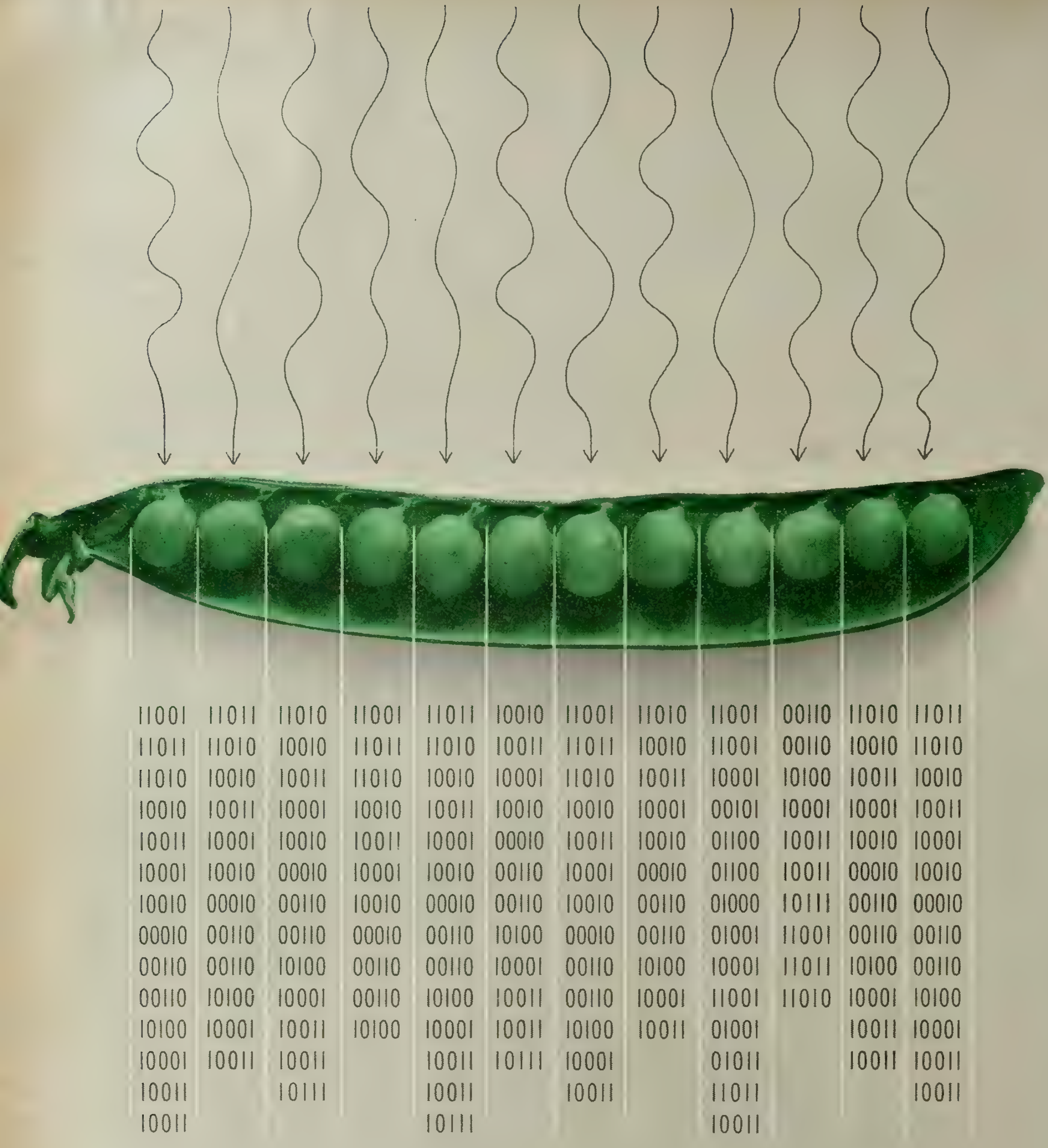
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 13 September 23, 1963

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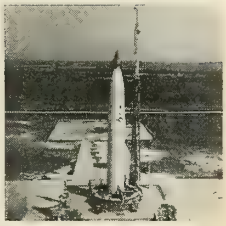

First ASSET vehicle is shown aboard Thor booster before successful Sept. 18 launch from Cape Canaveral. Six-shot ASSET series will test glide method and materials for X-20 Dyna-Soar re-entry. See page 18.

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letters

Soviet ABM Threat

To the Editor:

The article "Soviets May have Ultimate ABM," and the editorial "A Question of Survival," in the Sept. 16 M/R should be required reading for the Senate and anyone else in the country that has anything to do with the test ban treaty. As SAC Gen. Thomas S. Power says, we must determine the effect that nuclear weapons explosion electromagnetic phenomena has on our missile systems.

A very good source of background material for this is given in Chapter 10—"Radio and Radar Effects," of *The Effects of Nuclear Weapons* (U. S. Government Printing Office, Washington, D. C., 20402; $3.00). Sections 10.50 to 10.73, "Effects on Radio and Radar Signals," are especially good. The sections before are introductory in nature and the sections after deal with the technical aspects.

Examples to show the effect of radio transmission are given. I am quoting one below, from pp. 524-525: "Many instances of the interruption of HF propagation were observed in connection with the TEAK and ORANGE shots . . ." (according to page 676, these were multi-megaton shots in 1958 over Johnston Island at 252,000 and 141,000 ft., respectively). "For example, a 15-megacycle signal from WWVH, Hawaii, which was being received at Hiraiso, Japan, was lost for several hours following the burst. The signal path in this case passed within about 600 mi. of the point of detonation."

D. W. Johnston
Washington, D. C.

Congress and Personnel

To the Editor:

In your issue of Sept. 9, you may be overlooking a real point from the splendid letter to editor, "Personnel Runaround," from Winston-Salem, N.C., and your editorial, "Lessons from the Hill."

During the five years I have been associated with space systems engineering, the confusion and morale of personnel have been absolutely fantastic.

Myself and almost everyone that I know have at one time or another contacted a member of the United States Congress pointing out obnoxious extravagance, arrogance and futility being experienced in our missile programs and requesting that some action be taken immeditely.

It is just impossible to describe to an outsider the colossal amount of confusion, hurt and frustration caused by the personnel departments in our missile industry.

Complaints of the layman and engineer to Congress were not mentioned in your editorial.

On behalf of my children's future, I sure hope our Congress continues to take a real hard look at appropriations.

C. M. Bennett
Boulder, Colo.

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Structure Report Credit

To the Editor:

In your issue of Sept. 2, under the article, "Structural Problems of the '70's Listed," your subtitle stated that the report from which this article quoted was a Douglas-NASA document.

This document, NASA Technical Note D-2059, was prepared by the Research Advisory Committee on Missile and Space Vehicle Structures. I am a member of this committee and, while I acted as editor for this report, this was not a Douglas-NASA report.

I would like to assume full credit for this report, but in all fairness, the efforts of the other contributors must be recognized.

L. H. Abraham
Senior Technical Staff
Product Development
Missile & Space Systems Division
Douglas Aircraft Co., Inc.

Lens Underrated

To the Editor:

Relative to the Westinghouse infrared lens mentioned on p. 18 of the Aug. 12 issue, let me join those who noticed that the f/0.75 lens is stated to have twice the light-gathering capacity of an f/1.5 lens. Actually, of course, it gathers *four* times as much light, since the solid angle for reception varies inversely as the square of the f-number.

Let me also put in a word of support for more emphasis on training in optics for those concerned with the front lines of technology: few disciplines are so widely and effectively applicable.

E. Scott Barr
University, Ala.

Encyclopedia Reprints

Reprints of Missiles and Rockets' *Seventh Annual World Missile/Space Encyclopedia, which appeared in the July 29, 1963, issue, are now available. They may be ordered from:*

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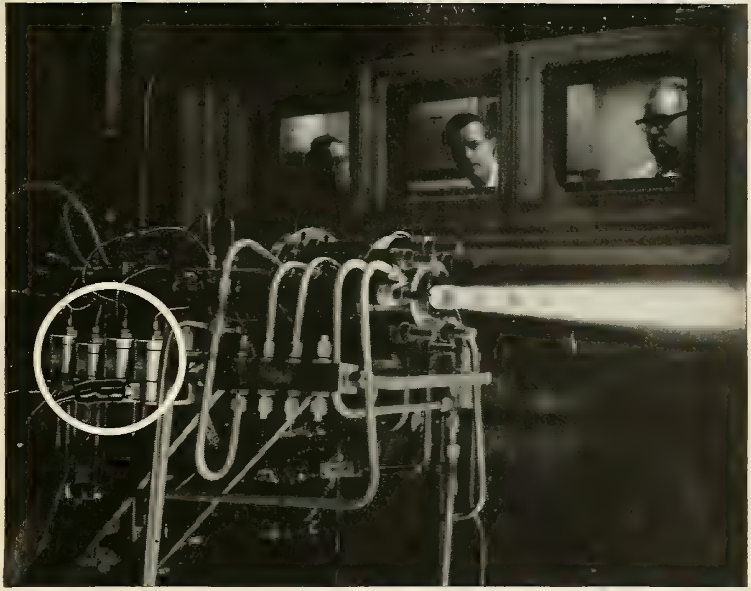

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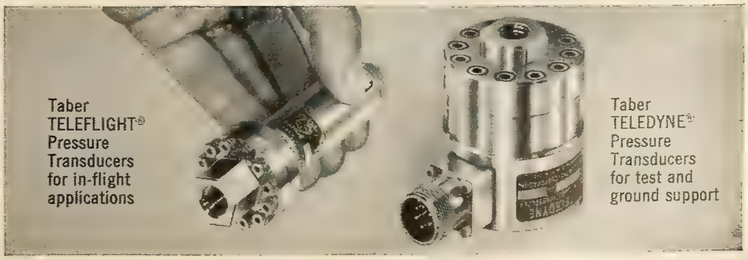
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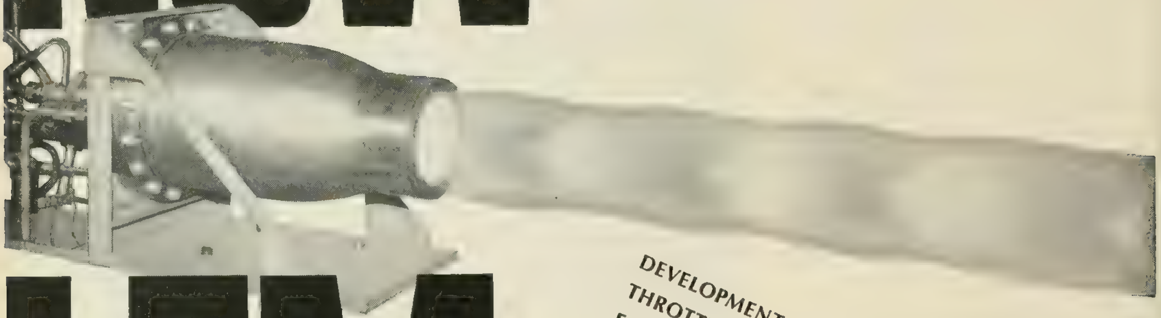

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The Countdown

WASHINGTON

MMRBM Back in Business?

Speculation that the *Mobile Medium Range Ballistic Missile* is a going concern again have reached a new high with rumors that the Air Force has given major contractors word to prepare for full resumption within the next three weeks. Many of the principal contractors and subcontractors have dispersed their *MMRBM* teams' and it's not known whether these groups are being re-formed.

Slow Going for Space Money

NASA's Fiscal Year 1964 budget may not emerge from Congress until November. The House Appropriations Committee, which is handling space agency funds in a lump Independent Offices Bill covering more than 20 other agencies, is not expected to report the bill until Oct. 1. NASA's budget probably will get a heavy slash in the House, but the Senate Appropriations Committee figure will be somewhat higher, making the total near the original House committee figure of $5.2 billion.

Longer Life for Saturn I

Saturn I and its S-IV upper stage could yield further mileage as one alternative launch vehicle for a minimal manned space station, a DOD observer commented last week. "You're not getting much for your money," he said of the early *Saturn,* which is to be used only for *Apollo* Earth orbit and a few later scientific experiments. But the Air Force *Titan III,* as yet authorized only for the *X-20,* would appear to be front runner at present as *NOSS* booster.

Academy Stresses Sterilization

Space Science Board of the National Academy of Sciences has issued a statement underscoring what it calls the necessity for spacecraft sterilization to prevent contamination of the Moon and planets. Part of the statement appears to be a reaction to NASA's recent relaxation of sterilization standards for *Ranger* and *Surveyor.*

Deep in the Heart of . . .

Although Manned Spacecraft Center maintains that a *Gemini* and *Apollo* landing site can't be chosen until actual unmanned flights of the *Gemini* and *Agena* target have taken place, four engineers doing NASA studies on rescue and recovery procedures based their papers on the primary site being in south Texas, with the backup site in the Pacific off Hawaii.

INDUSTRY

DOD Moving to Five-Year Buying

New, multi-year procurement procedures are provided in a set of changes to Armed Services Procurement Regulation (ASPR) forwarded by DOD to Aerospace Industries Assn. for distribution to its members. The new language, defining multi-year procurement on a five-year basis, will be incorporated in the next official undated ASPR.

NASA Spells Out Reliability Rules

NASA has adopted a set of uniform guidelines to be followed by contractors to assure reliability of space-system hardware. The new rules will apply to contracts worth more than $1 million. They're laid down in a publication, "Reliability Program Provisions for Space System Contractors," which is being distributed to affected contractors. Copies are also available from the Government Printing Office.

Thiokol Claims Lead in Sprint-Type Fuels

Spokesmen for Thiokol's Alpha Div. were dropping hints last week that a significant increase in burning rate has been achieved in their work on high-energy solid propellants for *Sprint*-type applications. They say they're confident Thiokol is farther down the line in this effort than the rest of the industry.

M-2 Can Use Aircraft Strip

Martin Co. reports that an *M-2* shaped orbital ferry should be able to land on existing 10,000-ft. jet runways if pilot visibility is adequate. Landing technique and flight instruments for an *M-2* have been demonstrated by the company, utilizing a landing technique conceived by NASA's Ames Research Center.

MILA Bid Openings in Offing

Bids will be opened in the next two months on an estimated $84 million worth of construction work at NASA's Merritt Island Launch Area (MILA). Biggest will be the estimated $55 million for the Vertical Assembly Building, on which bids will be opened Nov. 19. Bids for pad A of Complex 39—with an estimated $20-million cost—will be opened Oct. 23.

Sea Recovery Gear Sought

Manned Spacecraft Center has asked for bids by Oct. 3 on a study contract for sea retrieval equipment for Projects *Gemini* and *Apollo.* The investigation will include design concept, feasibility, preliminary design and model construction.

INTERNATIONAL

IAF Gathering in Paris

More than 1,000 persons are expected to attend the Fourteenth Congress of the International Astronautical Federation starting in Paris on Friday. French Astronautical Society President Georges Fleury says some 100 papers on space science and missile technology will be presented by U.S., Russian, French, British, Rumanian, Italian, Belgian, German, Czech and Norwegian delegates. Besides the Congress, IAF is concurrently holding the Sixth Colloquium of Space Law at the Centre des Conférences Internationales.

Progress Reported at Thumba

UN Committee on Peaceful uses of Outer Space is sending a team of five scientists to inspect the proposed UN sounding rocket launching site at Thumba, India. Work on the site is reported to be nearing completion. Limited operational status will be achieved in November, and the site is to be fully operational by the end of the year.

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The Missile/Space Week

Gilruth Admits Apollo Delay

Manned Spacecraft Center Director Robert R. Gilruth last week admitted the first attempt to land a man on the Moon in NASA's Project *Apollo* may slip beyond the fall, 1968 target date.

"I would not be surprised if we did not make it," Gilruth told a Washington audience, but he expressed hope of "getting there in this decade."

The space agency official also said that Project *Gemini* is still "absolutely essential" to the *Apollo* program.

Gilruth said that even if *Gemini* were delayed until it ran concurrently with *Apollo*, the former project would be needed for the flight experience it would give astronauts, particularly in rendezvous and docking.

Cosmos Called Spy Satellite

It was openly suggested last week that the Soviet Union's *Cosmos* satellites have been operating as reconnaissance vehicles over the U.S., in addition to performing regular scientific missions.

Dr. Edward C. Welsh, executive secretary of the White House's National Aeronautics and Space Council, hinted that the 18 *Cosmos* satellites launched since March, 1962, are the Soviet counterpart to the U.S. *SAMOS* satellites that have photographed virtually every part of the Soviet Union since the suspension of U-2 flights in 1960.

Though never acknowledged, it has been known that both space powers have increasingly engaged in "spying" with satellites. Because of the "open society" of the U.S., the Soviets do not have the pressing need this country has for space reconnaissance, said Dr. Welsh.

It is not believed that the Soviet Union has as effective a reconnaissance program as the U.S. However, indications are that the Soviets want to advance in this field, if only to determine how much information the U.S. is obtaining in the *SAMOS* program.

Shots of the Week

The Sept. 18 firing of *ASSET*, an Air Force "flying laboratory" designed to gather data on structural behavior of winged space gliders during flight, was said to have met "all primary objectives," despite failure of efforts to recover the craft itself. Most of the data sought was attained by telemetry during the flight.

Other shots of the week:

- The Air Force completed the 13-shot Cree Program series Sept. 12 at its Santa Rosa Island, Fla., launch site. The Cook Electric Co.-built Cree payload was carried aloft by an *Honest John-Nike* rocket combination. Cree is a high-altitude, high-Mach-number parachute test program conducted by Cook Electric and the Air Force's Aeronautical Systems Div.
- A Strategic Air Command crew successfully launched an Air Force *Atlas* ICBM Sept. 11 from Vandenberg AFB, Calif.
- The Air Force fired a *Titan I* ICBM bearing a dummy nuclear warhead from Vandenberg AFB, Calif., Sept. 17. Shot was aimed at a target 5,000 miles down the Pacific Missile Range.

NASA, Scandinavia in Pact

NASA and the Scandinavian Committee for Satellite Telecommunication have announced approval of a Memorandum of Understanding for testing experimental communications satellites.

NASA received the Danish government's note Sept. 14 approving the memorandum, which brought the agreement into effect. Norway and Sweden, the other committee members, had previously approved the memorandum.

Under the agreement, the Scandinavian Committee will provide a ground station to receive multichannel telephonic or telegraphic signals transmitted from a U.S. ground station via an orbiting communications satellite.

'Hitchhiker' Data Disclosed

Data gathered by twin "hitchhiker" satellites launched earlier this year was made public last week, providing considerable information on radiation damage to solar cells.

The telemetered data also added to the understanding of the energy distribution and intensity of space radiation.

An *Atlas-Agena* combination sent the two hitchhikers aloft from the Pacific Missile Range last May 9 in a launch that successfully orbited Project West Ford's copper space needles.

It marked the first time two subsatellites had ever been successfully ejected simultaneously from an orbiting space craft. A Tetrahedral Research Satellite (TRS), carried the second and third in a series of experiments being conducted for the Space Systems Division of the Air Force Systems Command.

TRS, a tiny (1½ lbs.) space research vehicle, was developed by Thompson Ramo Wooldridge's Space Technology Laboratories to ride on a variety of spacecraft.

Through Sept. 1, tape containing some 300,000 analog data points had been collected from the hitchhikers by NASA's Minitrack network.

The data has shown best how to design power supplies for spacecraft that must travel in and through the Van Allen belts.

AF to Issue NOSS RFP's

The Defense Department has given the Air Force the go-ahead on requests for proposals on the National Orbiting Space Station. But officials were quick to spike speculation that the move was an indication that DOD might eventually manage the joint NASA-DOD program.

"Before we start worrying who's going to manage the program, we've got to figure out what it's going to be," said one Pentagon official close to the subject.

He said that the RFP's for about $1 million in conceptual configuration and systems studies amount to "giving the Air Force a few more cards in their hand." DDR&E officials have yet to be satisfied completely with justifications for manned military missions in space.

The manned space flight panel of the NASA-DOD Aeronautics and Astronautics Coordinating Committee has been considering the question of what shape the single space station program should take. Not until after completion of a cluster of DOD and NASA studies will any decision on program management be made, officials said.

House OK's R & D Committee

Congress has made another effort to get a firmer grip on government research, approving the founding of a select House committee to investigate R & D.

The new group, headed by Rep. Carl Elliott (D-Ala.), will have until Dec. 1, 1964, to delve into all phases of the $14.9 billion Government R & D effort. The bulk of this is supported by DOD and NASA (M/R, Aug. 19, p. 15).

Expanding Activity in ROCKETS Creates New Positions with Bell Aerosystems Company

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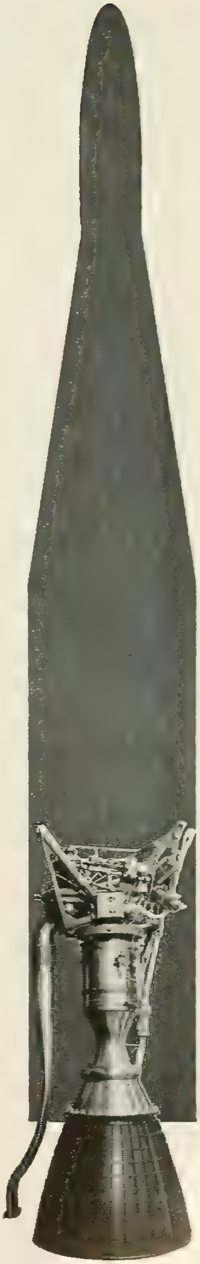
To conduct analytical and design studies and investigations in all areas of liquid propellant rocket engines and injector systems. To be responsible for conceptual design and supporting analysis for new rocket propulsion systems. To evaluate current designs and project future requirements. Requires an advanced degree in ME, AE, ChE or Applied Physics with a structures specialty in sequence, plus 6 to 12 years analytical experience in thermodynamics, fluid dynamics, or heat transfer related to the above. Salary to $18,000.

Bell Aerosystems Co. will provide the primary rocket propulsion (with the Agena engine) and the secondary propulsion system for the Agena D target vehicle with which the 2-man Gemini spacecraft will rendezvous. Bell's AGENA rocket engine has injected into orbit more satellites and more weight than all other U.S. rocket engines combined.

Bell has also developed the reaction controls for Project Mercury and other space vehicles, the first rocket belt for man in free flight, and a zero-gravity belt for man's use in outer space.

Current investigations include very high energy rocket engines, development of a multiple re-start engine, and new applications for advanced rocket engines.

Resumes are invited from Engineers qualified for positions in one of the areas listed above. Please address Mr. Thomas Fritschi, Dept. C-36.



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In Complete Switch . . .

Soviets Eye Joint Moon Landing

Blagonravov conveys position to Dryden; U.S. officials cautious

by Hal Taylor

THE SOVIET UNION for the first time has indicated official interest in a joint U.S.-USSR lunar-landing program.

While no agreement is imminent, the Russian's new position represents a complete about-face in its international space policy. The Soviet timetable for talks leading to such an agreement, however, leaves much to be desired.

The new Soviet position was disclosed to MISSILES AND ROCKETS by Dr. Hugh L. Dryden, Deputy NASA Administrator.

Dryden said Soviet Academician A. Blagonravov has informed him that "once the two nations have landed instrumented payloads on the Moon discussions of cooperation in a manned lunar-landing program should begin."

Dryden, chief U.S. negotiator in space cooperation talks with the Russians, said "it's the first time they have indicated interest in a joint effort."

"The climate has changed," Dryden said. "It is somewhat more favorable."

The statement by Blagonravov, Dryden's Soviet counterpart in negotiations, is much more than that—it is a complete reversal of position. Previously, the Soviets have held that no cooperation with the U.S. would be possible in manned spaceflight area until the first manned lunar landing had been achieved.

Dryden's conversation with Blagonravov took place at a private luncheon during the current meeting of the UN Committee on Peaceful Uses of Outer Space.

The meeting followed an Aug. 23 letter from Dryden to the Soviet scientist questioning whether there was any merit to a report by Britain's Sir Bernard Lovell of a change in Russian thinking.

• **Cost the crux?**—Behind the Soviet switch apparently is the great expense of the lunar-landing program. Blagonravov—in discussing a previous agreement to exchange weather satellite data—told Dryden that "not everybody is enthusiastic about it." He said many Russians favor more industrial development rather than the commitment of funds to the space program.

Blagonravov also said that while he is a proponent of a manned lunar landing program, there has been a lot of discussion within the Soviet Academy of Sciences as to whether it is really worthwhile.

The Soviet timetable for consideration of a joint program is not exactly tailored to cutting costs. In limiting the start of the talks until after instruments have landed on the Moon and information obtained as to its surface, the Soviets have put off the talks for at least one to three years.

It is certain to take that long before the two nations land such unmanned payloads on the Moon.

It is also certain that by that time the U.S. and, very likely, the Soviet Union will be well into hardware development of their respective spacecraft and launch vehicles for the manned mission. This could make the integration and interface problem in a joint program almost insurmountable.

• **Wary reaction**—While President Kennedy in several speeches has indicated this country's willingness to engage in all forms of peaceful cooperation in space, the Blagonravov statement has evoked a certain amount of reticence among U.S. officials.

Some say they feel that if the U.S. asks for further talks, "it will put us in a bad bargaining position."

Dr. Dryden said that there are no immediate plans for bilateral discussion of the Soviet proposal. He added that as far as he is concerned there are still great difficulties in working out an agreement for a joint lunar program.

The switch in the Soviet position was also revealed by Blagonravov in a talk with Chairman George Miller (D-Calif.) of the House Space Committee and in a speech before the UN committee.

Miller called the change in Soviet position a 180-degree turn. He said that Blagonravov indicated a willingness to cooperate with the U.S. in all areas of space flight. ■

Atlas Booster To Be Used in Fluorine Tests

LOS ANGELES—An *Atlas* booster left over from the *Mercury* program will be used for tankage tests of fluorine/oxygen.

The cold-flow tests, directed by NASA's Lewis Research Center, will be run at the General Dynamics/Astronautics facility here.

GD/A officials believe a fluorine-fueled *Atlas* could replace the *Titan II* booster in the *Gemini* program if technical problems with the Martin launch vehicle continue.

Although NASA at present has no plans to static-fire or launch a fluorine *Atlas*, it is possible that two other *Atlas* boosters left over from *Mercury* could be modified for such tests.

Rocket men believe only minor modifications in the *Atlas* engines will be needed to handle the fluorine mixture. These mainly concern seals in the propellant handling system, airborne and ground, to withstand fluorine corrosion.

Simultaneously, consideration is being given by industry and NASA to the possibility of launching *Gemini* atop the *Atlas*.

Theoretical and experimental specific impulse figures are classified. However, engineers have cautiously conceded that the *Atlas*, equipped with a fluorine tank in the same configuration planned for *Centaur* flights, would pose no mating problem with the *Gemini* spacecraft. The specific impulse obtainable through the fluorine mixture specified by the Lewis Center should be more than adequate to put the maximum *Gemini* weight into orbit, one propulsion engineer said.

The *Atlas* standard launch vehicle now will provide thrust equal to the latest missiles—in excess of 390,000 lbs.

Short life a liability . . .

Nimbus Program May Be Scrapped

Meteorological satellite would be replaced by heavier, more versatile system with three-to-five-year operating capability

WEATHER BUREAU officials apparently are ready to scrap the *Nimbus* satellite and replace it with an operational system that will have a three-to-five-year capability.

The new, heavier meteorological satellite could also be used for data gathering and as a civilian navigational system.

Bureau officials reportedly believe that the *Nimbus* satellite is too expensive and has too short a lifetime to meet the needs of an operational weather satellite system.

"*Nimbus* is designed for a six-month operating capability, but we'll be lucky to get two months," one official said. He added that the new satellite would have a three-to-five-year lifetime and that two of them in polar orbit would meet all the requirements of an operational system.

The longer lifetime would mean fewer satellites and launch vehicles would be needed, thus cutting the cost of the systems.

- **Versatility stressed**—He added that the new satellite could also carry equipment that would permit it to gather data from weather ground stations in many areas. One example cited is the newly opened Fairbanks, Alaska, Weather Bureau station.

He said that with the addition of inexpensive equipment, the new satellite could also be used to meet the requirements of a civilian navigational system.

What role NASA's proposed *Synchronous Meteorological Satellite* would play in the proposed system, if any, is not clear. One such satellite in synchronous orbit might possibly be used to augment and complete the coverage of the two polar-orbiting spacecraft.

The Weather Bureau position apparently is the result of in-house studies of future meteorological satellite systems being conducted by both the bureau and NASA.

Dr. Morris Tepper, director of the space agency's meteorological systems, refused to discuss the in-house studies. He said, however, that decisions affecting the future weather satellite systems will be made in four to six months. As far as *Nimbus* is concerned he said, no decision affecting it should be made until one has been launched and its operating efficiency tested. The first *Nimbus* launch is now scheduled for early next year.

- **Nimbus support**—He also questioned the lack of faith in *Nimbus's* projected lifetime. He pointed out that the *Tiros* weather satellite was supposed to last only four months, but that *Tiros VI* has already chalked up a full year orbit.

The possibility of the new satellite system was learned as the Weather Bureau dedicated its National Weather Satellite Center Data Processing and Analysis Facility at Suitland, Md.

The facility is designed to handle the requirements of the *Nimbus* system as well as any future system.

Its three basic outputs will be:

—TV photos of the Earth's cloud cover as seen by the *Nimbus* weather satellite, but with computer-produced latitude and longitude grid lines superimposed.

—Computer-generated cloud mosaics, based upon these TV pictures (for daylight coverage) and upon *Nimbus*-derived infrared observations (for nighttime coverage)—these mosaics being rectified or displayed by the computer as polar stereographic and Mercator map projections.

—Numerical grid point data, representing cloud cover information according to selected locations on the Earth's surface.

The new NWSC computing facility is a combination of major systems provided by the IBM Corp., Control Data Corp., ESS GEE, Inc., and the Radio Corp. of America. ■

Passive Comsat Future Looks Dim

NO NEW PASSIVE communication satellite flight program is expected for at least two years.

Even then, a new program will depend upon its technical improvements and its possible use by the Communications Satellite Corp. and the Dept. of Defense.

Edward Rogers, director of NASA passive comsat programs, said that in order to be economically feasible, passive satellites will have to achieve a significant technological improvement.

This would include a satellite providing 10 times the communications capacity as *Echo II* with little or no increase in weight.

At this point, a possible future flight program is doubtful. NASA is busy with its active satellite programs such as *Relay, Syncom* and the *Advanced Synchronous Communications Satellite*. One potential user, the Comsat Corp., has conducted a study which indicates that passive satellites will never be economically competitive with active satellites.

DOD continues to express interest in passive satellites, but still has not authorized a flight program.

One main advantage of the passive satellite over its active counterpart is that it provides multiple access for ground stations.

To enhance this advantage, NASA is studying a 425-ft.-dia. concave-shaped satellite. The space agency is studying two types of guidance systems to keep such a satellite in a precise orbit—a gravity gradient type system and an electromagnetic system.

Senate Approval Seen For $47.4-billion DOD Budget

Appropriations committee restores only $289 million of nearly $2 billion slashed by House; no manned military space program funds provided

by Heather M. David

THE SENATE Appropriations Committee last week restored only $289 million of the nearly $2 billion the House of Representatives had slashed from the Fiscal Year 1964 Dept. of Defense budget. Included were partial restorations in funds for the *Mobile Medium Range Ballistic Missile (MMRBM),* the defense communications satellite, and the *Lance* missile.

In approving a $47.4-billion DOD budget, the committee denied a request by the Department to change the language covering $125 million earmarked by the House for "*Dyna-Soar,*" or "Mach 3 aircraft," to include "space vehicles." Chairman Richard B. Russell (D-Ga.) of the Defense appropriations subcommittee pointed out that "there's no more nebulous term today than 'space vehicles'," and that DOD has failed to spell out what it would do with the funds if it were given such leeway.

The total amount approved by the Senate committee is $1.643 billion below the Department's request, and almost $1 billion less than the approved FY 1963 budget.

Following anticipated approval of the bill by the full Senate this week, a Senate-House conference will resolve the differences between the Senate measure and the $47.1 billion recommended in the House bill.

No mention was made in the committee's report of a manned military space program, although Russell expressed his personal opinion that he was "not content" with military activities in this field.

• **Economy prevails**—The Pentagon's strategy was to agree with a large percentage of the House cuts but make a strong request for restoration of $443 million more than the House appropriated. Assistant Secretary of Defense Roswell L. Gilpatric had told the Senate committee that anything less "would hamper the running of the military establishment." However, this failed to keep the Senate from letting the total slip well below this amount.

In fact, Sen. Leverett Saltonstall (R-Mass.), and Sen. Allen Ellender (D-La.) both proposed amendments to the committee to make additional across-the-board reductions. These would have meant a further 1% slash in procurement, and a 2% slash in RDTE, respectively. Both amendments were defeated.

• **RDT&E**—The Senate appropriated $6.984 billion in research, development, test and evaluation funds, an increase of $95.2 million over the House bill, and $277.8 million less than the original budget request.

—Air Force ($3.484 billion)—The Senate restored $67.230 million over the House allowance. The largest restoration—*MMRBM* ($60 million) will allow DOD about $103 million to proceed with Phase II development (M/R, Sept. 16, p. 10), but does not allow procurement.

The 3% general reduction in RDT&E specified by the House was accepted in the Senate, except for a fund of $7,230,000 which had been cut from a classified project.

While the 3% is an across-the-board reduction, the Senate said that no more than 10% can be cut from these programs: aircraft and related equipment, missiles and related equipment, stellar inertial guidance, and large solid boosters. The Senate also pointed out that $108 million was available from prior appropriations to finance a total FY 1964 budget of $3.591 billion.

This provides about $983.8 million for missiles and related activity—including funds for completion of *Atlas* and *Titan,* as well as development funds for *Minuteman* and *Improved Minuteman* including a new second-stage engine to increase range and payload and an improved guidance system.

Air Force participation in the Defense communications satellite program was set at $50.7 million; this calls for development, procurement and launch of sufficient satellites to perform an R&D demonstration of the random-orbit comsat system. "Substantial" funds also are included for continuation of the *Titan III* standard space launch system.

Air Force military sciences programs will have $122.6 million.

—Army ($1.391 billion)—One of the largest restorations was a $23-million item for the communications satellite program, bringing the total appropriated to $96.7 million.

The *Lance* missile, which had been cut by $5 million, was fully restored by the Senate. Army RDTE includes $216.9 million for military sciences, $559.3 million for surface-to-air missile systems and guided missile R&D. *Nike-Zeus* and *Nike-X* are to be emphasized; development will continue on *Mauler* and related equipment; *Sprint;* improvement of *Nike-Hercules;* and providing *Hawk* with anti-tactical missile capability. Surface-to-surface missile funding includes continued development money for *Lance, Pershing* and *Sergeant.*

Army military astronautics will get $19.6 million for support of communications satellite programs of the DOD and NASA.

—Navy ($1.526 billion)—The Senate agreed with the House version,

ITEM	APPROPRIATIONS, 1963 (TO DATE)	BUDGET ESTIMATES, 1964	RECOMMENDED IN HOUSE BILL, 1964	AMOUNT RECOMMENDED BY SENATE COMMITTEE	INCREASE (+) OR DECREASE (−), SENATE BILL COMPARED WITH—		
					APPROPRIATIONS, 1963	BUDGET ESTIMATES, 1964	HOUSE BILL
Military Personnel	$12.992,690,000	$13,235,200,000	$12,848,200,000	$12,850,700,000	−$141,990,000	−$384,500,000	+$2,500,000
Operation and Maintenance	11,688,724,500	11,792,237,000	11,678,337,000	11,741,030,000	+52,305,500	−51,207,000	+62,693,000
PROCUREMENT							
Procurement of equipment and missiles, Army	2,520,000,000	3,202,000,000	2,958,894,000	2,962,794,000	+442,794,000	−239,206,000	+3,900,000
Procurement of aircraft and missiles, Navy	[1] 3,034,660,000	3,066,000,000	2,877,445,000	2,928,845,000	−105,815,000	−137,155,000	+51,400,000
Shipbuilding and conversion, Navy	[2] 2,919,200,000	2,310,000,000	2,080,089,000	2,068,089,000	−851,111,000	−241,911,000	−12,000,000
Other procurement, Navy	903,600,000	1,208,000,000	1,175,231,000	1,175,231,000	+271,631,000	−32,769,000	...
Aircraft and related procurement, Navy	...	(3)	(3)	...	...	...	...
Procurement, Marine Corps	256,000,000	207,700,000	201,960,000	201,960,000	−54,040,000	−5,740,000	...
Aircraft procurement, Air Force	3,562,400,000	3,559,000,000	3,328,900.000	3,395,075,000	−167,325,000	−163,925,000	+66,175,000
Missile procurement, Air Force	2,459,000,000	2,177,000,000	2,129,490,000	2,141,990,000	−317,010,000	−35,010,000	+12,500,000
Other procurement, Air Force	956,250,000	951,500,000	871,299,000	878,299,000	−77,951,000	−73,201,000	+7,000,000
Procurement, Defense Agencies	36,000,000	43,600,000	43,164,000	43,164,000	+7,164,000	−436,000	...
Total	**16,647,110,000**	**16,724,800,000**	**15,666,472,000**	**15,795,447,000**	**−851,663,000**	**−929,353,000**	**+128,975,000**
RESEARCH, DEVELOPMENT, TEST AND EVALUATION							
Research, development, test, and evaluation, Army	1,319,500,000	1,469,900,000	1,363,141,000	1,391,141,000	+71,641,000	−78,759,000	+28,000,000
Reserach, development, test, and evaluation, Navy	1,475,958,000	1,572,900,000	1,525,713,000	1,525,713,000	+49,755,000	−47,187,000	...
Research, development, test, and evaluation, Air Force	3,632,100,000	3,621,800,000	3,416,146,000	3,483,376,000	−148,724,000	−138,424,000	+67,230,000
Research, development, test, and evaluation, Defense Agencies	444,000,000	447,400,000	434,000,000	434,000,000	−10,000,000	−13,400,000	...
Emergency Fund, Defense	[4] 150,000,000	[4] 150,000,000	[4] 150,000,000	[4] 150,000,000	...	...	...
Total	**7,021,558,000**	**7,262,000,000**	**6,889,000,000**	**6,984,230,000**	**−37,328,000**	**−277,770,000**	**+95,230,000**
GRAND TOTAL	**48,350,082,500**	**49,014,237,000**	**47,082,009,000**	**47,371,407,000**	**−978,675,500**	**−1,642,830,000**	**+289,398,000**

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[1] In addition, transfer of $165,000,000 from "Aircraft and related procurement, Navy."

[2] In addition, $20,000,000 to be derived by transfer.

[3] Language terminating account.

[4] In addition, $150,000,000 to be derived by transfer from other appropriations available or obligation in the respective fiscal year, and authority to transfer an additional $200,000,000 under certain conditions.

which applies only the 3% general cut. None of this reduction may come from the *ANNA* geodetic satellite or the *Transit* navigational satellite program, the Senate specified.

Military sciences will get $175.6 million. Missile RDT&E, which totals $572.4 million, includes funds for development of *Polaris A3,* and for bringing *Terrior, Tarter* and *Talos* surface-to-air missiles up to present standards. Development will continue on the *Subroc* sub-launched missile and *Shrike* anti-radiation missile. *Typhoon* and *Sea Mauler* have some development funds, and monies are provided for an advanced sea-based deterrent program to complement or follow *Polaris.*

The Navy military astronautics funds of $40.3 million are for improvements in the Spasur program, and continued development of *Transit* and *ANNA.*

—Defense agencies ($434 million) —The committee recommended concurrence with the House allowance, including the 3% general reduction. No part of this, however, may be taken from the Defender antimissile systems, or *Vela Hotel* nuclear detection satellite programs of ARPA.

- **Procurement**—Total Senate procurement appropriations for DOD amounted to $15.8 billion. The budget request of $16.725 billion was cut by the authorization act by $314 million. The House cut appropriations by $744 million, of which the Senate restored $129 million.

—Army ($2.963 billion)—The only restoration from House-cut funds was $3.9 million for procurement of instrument trainer helicopters. The Senate went along with the 1% general reduction, plus $96.3 million in *Mauler,* $2.23 million in missile spare parts, and $22.8 million in communications and electronic equipment.

—Air Force ($6.415 billion)—The Senate restored $66 million over the House bill for aircraft, $12.5 million for missiles, and $7 million in other procurement. The 1% across-the-board cut was upheld.

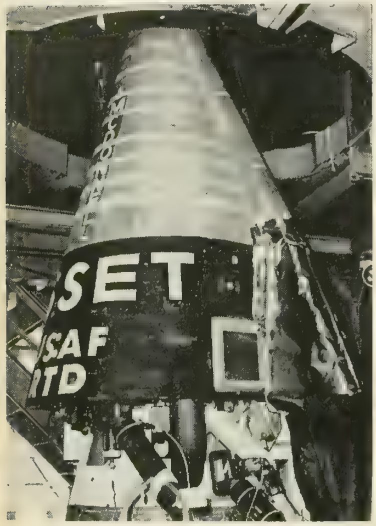
Missile restorations actually amounted to bookkeeping transfers. The bill now provides for about $1.720 billion in ballistic missiles and $191.2 million for other missiles.

—Navy ($2.929 billion)—Restorations by the Senate were confined to trainer and Intruder aircraft. The Committee supported House cuts in the missile programs in general of 1% ($29 million), and $1.29 million in the *Typhon* missile program.

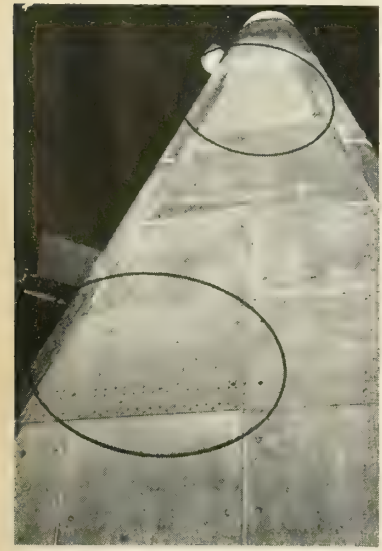
—Marine Corps—($201.9 million) The 1% cut was upheld, leaving about $14.7 million for *Hawk* missiles and $95 million for communications and electronics equipment. ■

Qualified winged victory . . .

First ASSET Transmits Valuable Data Before Disappearing in Atlantic



ABOVE: McDonnell's ASSET ASV-1 vehicle shown in closeup prior to mating with Thor boster for Sept. 18 launch from Cape Canaveral. BELOW: Circles indicate two panels on vehicle's flat bottom containing materials slated for use in Dyna-Soar. Boeing Co. supplied sections.



by Chris Butler

CAPE CANAVERAL—The first of six *ASSET* test vehicles designed to gather data for the *X-20 Dyna-Soar* program completed a near-perfect 1,000-mi. gliding flight down the Atlantic Missile Range Sept. 18, but sank into the ocean before it could be recovered.

An Air Force spokesman said that scientists were "very pleased" with telemetry data received throughout the trip from the 1,100-lb. spacecraft, built by McDonnell Aircraft Corp., and that all primary objectives of the flight were achieved.

He said the Air Force had believed that there was only a 20% chance of picking up the vehicle, and recovery would have been "a real bonus." But he added that a better flotation method was being developed for future shots.

The series of *ASSET (Aerothermodynamic/elastic Structural Systems Environmental Tests)* launches, which will cover a 17-month period, includes four *ASV (Aerothermodynamic Structural Vehicles)*, of which the Sept. 18 shot was the first, and two *AEV (Aerothermodynamicic Environmental Vehicles)*.

The $34-million program will check out the glide method of re-entry and test materials and designs which may become part of *Dyna-Soar* and the *Aerospace Plane*.

- **Up and down**—A rebuilt Douglas *Thor* IRBM, one of those formerly on station in Britain, boosted the delta-shaped *ASV-1* on a 110° azimuth to an altitude of 195,000 ft., where separation took place.

The heavily instrumented *ASSET* was traveling 10,900 mph and heating to about 4,000°F as it started the 10-min. glide that terminated with letdown near Antigua. Recovery ships and planes spotted a drifting dye marker and briefly detected the SARAH beacon, but found no sign of the vehicle. A SOFAR bomb apparently failed to explode.

During the flight, 104 measurements were scheduled to be directly transmitted by telemetry. They included 59 for temperatures, 35 for pressures, six for deflections, and four for accelerations.

Data was returned by both standard VHF frequencies and X-brand telemetry. The latter was used to pierce the blackout sheath caused by ionization of the rarified atmosphere.

Designers were looking for verification of predictions concerning temperatures, pressures and heat transfer rates; correlation of aerodynamic heating, lift, drag and pressure prediction methods and theories; and evaluation of design concepts and material usage.

The gliding flight was made at a 38° angle of attack. A peroxide jet system similar to that used in *Mercury* capsules provided stability during re-entry.

The recovery sequence was initiated at 75,000 ft. by barostatically controlled switches after the spacecraft had slowed to 950 mph and heating had dropped far below the 4,000° maximum.

A drogue chute was deployed to achieve stability and the main chute was opened at 25,000 ft. to permit gentle impact with the ocean. Pararescue men of the Air Rescue Service were waiting to drop and fasten flotation gear on the spacecraft.

Project officials had hoped to recover *ASSET* because it would permit them to study the effect of re-entry heating on materials and to determine structural behavior of the vehicle. They also wanted to retrieve the on-board tape recorder and its load of data.

- **Configuration**—The *ASSET* program got under way in June, 1960, when McDonnell was awarded a contract for a structural glide vehicle study. The order to proceed with production came 10 months later.

The result is a vehicle with an aerodynamic configuration and a flat bottom. It is 68.7 in. long, 58.9 in. wide, and the 70° swept wing has 14 sq. ft. of area.

Materials used in *ASSET* include molybdenum, graphite, beryllium, zirconium oxide and alloys of titanium, cobalt, molybdenum, columbium and aluminum.

Two of the bottom panels, furnished by the Boeing Co., were made of materials scheduled for use in *Dyna-Soar*. The two molybdenum panels were coated with a disilicide compound and one was instrumented for the flight. (See photo.) ■

Senators split . . .

Treaty Debate Underscores Lack of Electromagnetic Data

THE PROBLEM of the electromagnetic effects of a multimegaton nuclear warhead explosion—called "the most debated topic" in the Senate's test ban treaty deliberations—seemingly could not be resolved by the United States because of lack of experimental data.

Opponents last week said that by signing the treaty the nation could be maneuvered into a position where ignorance could deprive it of its second-strike deterrent. They were referring to the possibility that the electromagnetic effect of relatively few such warheads could "kill" large numbers of missiles in their silos by destroying their electronics, or effecting a communications blackout.

Senators favoring the test ban for the most part cited the weight of military and scientific authority to indicate the Soviet has no such anti-ballistic missile (ABM) capability.

- **For the treaty**—Sen. Stuart Symington (D-Mo.), admitting that U.S. information on the effects of explosions of large nuclear bombs is based only on extrapolations of data from smaller explosions, assured the Senate that the Soviet is not ahead. "The evidence is that the Soviets know no more than we do about (missile site) vulnerabilities," he said. "The evidence is that they have not conducted any large-yield tests of this kind."

Sen. Clinton Anderson (D-N.M.) said he was surprised "to hear so many people refer to the need for development of an anti-ballistic missile system and the fact that we have not conducted high-yield tests." Asserting that the U.S. does not lack data about high-altitude megaton explosions, he pointed out that three tests, part of the Argus series in the South Atlantic, were conducted above 300 miles altitude solely for weapons effects purposes. These tests, however, were all in the low kiloton range.

Continuing his thesis, Anderson said that prior to the Argus tests, two megaton-range shots were made at high altitude above the Pacific Ocean, near Johnston Island. Their effects "on the communications spectrum were studied intensively and were studied from different locations, close in as well as worldwide," he said.

He also referred to five other weapons effects tests conducted in 1962, of which the well-known Starfish 1.4 megaton explosion was a part. "I repeat," said Anderson, "we have done more than the Russians have done in (this) field."

Sen. George A. Smathers (D-Fla.), when asked if atmospheric tests were essential to determine the electromagnetic violence a large megaton explosion could do to siloed missiles, paraphrased Harold Brown, director of Defense Research & Engineering: "it is possible to conduct underground tests and learn from them almost as much as one could from tests in the atmosphere."

Smathers pointed out that the weight of the testimony of expert witnesses regarding the Soviets' ABM was ". . . our system of anti-ballistic missile development was as good as theirs."

Sen. Hubert H. Humphrey (D-Minn.) brought to bear the testimony of the Joint Chiefs of Staff, who testified they "have not regarded as important the attainment of weapons in the 100-megaton range." He joined with Smathers in concluding that "with respect to the anti-ballistic-missile missile, the overwhelming body of evidence indicates that our knowledge in this field is equal to that of the Soviets, or superior."

- **Against ban**—Sen. Strom Thurmond (D-S. C.) repeatedly emphasized that the U.S. lacks knowledge about the "exotic" effects of nuclear explosions of 60 or more megatons, simply because the U.S. has never made such tests. Holding that such an explosion conceivably could knock out the electronics in siloed missiles over a large area, he warned against the crippling effect this would have on the U.S. second-strike capability.

"If (the Soviet) did gain sufficient knowledge to be able to make our missiles inert or inoperable in the silos, and since Secretary McNamara is 'phasing out' our bombers—so that soon we shall not have any bombers, and if our missiles are made inert, and inoperative, where will America be?" the Senator asked.

Backing Thurmond, Sen. Richard B. Russell (D-Ga.) pointed up the danger of the Soviet having superior knowledge of high-yield tests which "the treaty would prohibit us from acquiring." He maintained that the U.S. advantage in the low-yield field would be quickly eroded by the Soviets' continuing underground testing.

- **Decision in a vacuum**—A seasoned observer of the debates noted that they settled down to the question of which set of authorities one chose to believe: there could not possibly be a conclusion because the U.S. did not have any evidence to base it on, unless there was intelligence evidence that had not been referred to or released.

At the same time accusations that the Administration was using security classification to gain its ends were strongly voiced. Sen. Thurmond, among the most vocal, complained:

". . . unfortunately, the information most detrimental to the Administration's position is the most difficult to get the Administration to declassify, while most everything that helps the Administration's case is . . . made public. ■

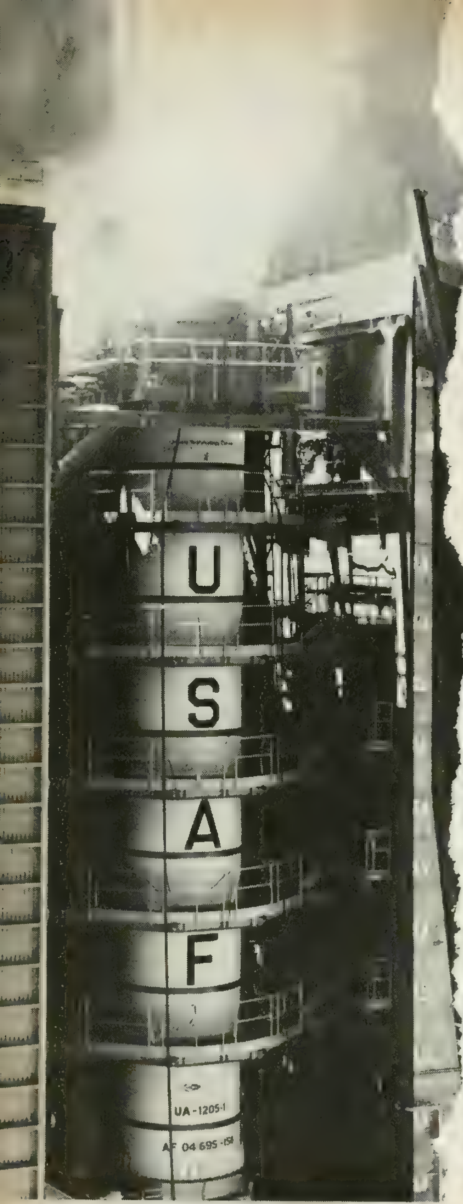
PUBLICATION in the Sept. 16 issue of MISSILES AND ROCKETS of an exclusive story on the Soviet ABM threat figured largely in stepping up the discussion of this aspect of the nuclear test ban treaty during the final days of U.S. Senate debate.

The M/R article was reprinted in full in the Congressional Record, and frequently referred to by Senators—both pro and con treaty—on the Senate floor.

It also was quoted in news service dispatches and in separate stories in a number of metropolitan newspapers.

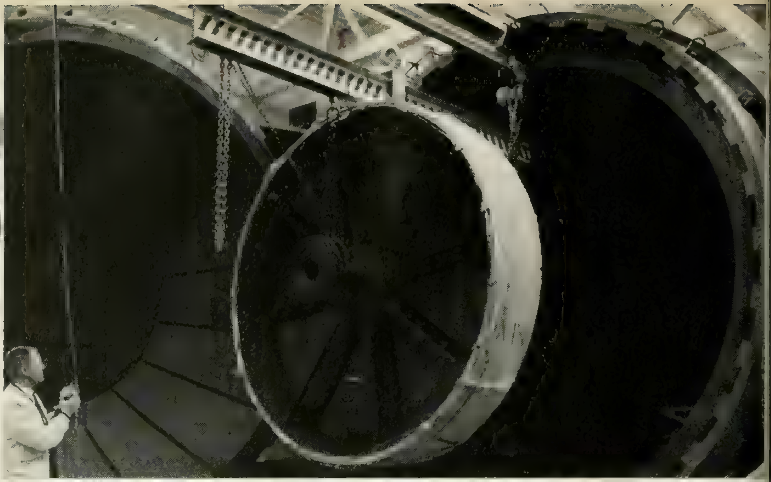
Overseas, the article was reported in the daily press in Great Britain and France.

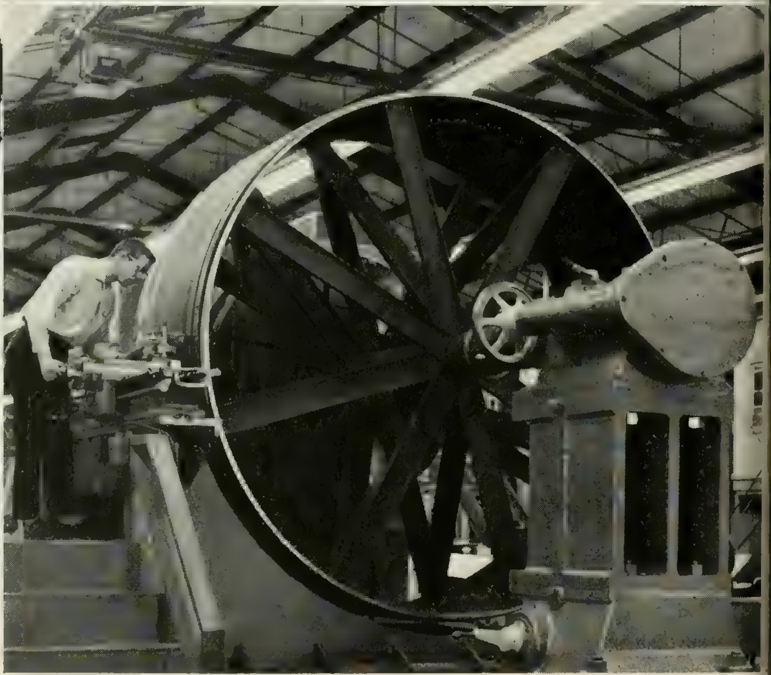
(See page 50)



lightiest solid-propellant rocket ested by United Technology Center

xhaust flames leap 200 feet from the nozzle of a 250-ton
olid-propellant rocket motor in a static test at the
oyote, Calif. test site of United Technology Center.
ne motor, the largest solid-propellant rocket ever fired,
roduced a peak thrust of 1 million pounds. Two of
e 75-foot tall rockets will make up the first stage of
e Air Force Titan III-C space booster. Mission:
meet requirements in the 5,000-25,000 pound
yload category for relatively low altitude orbits,
nging from 20,000 pounds in a 100 nautical miles
bit to 13,000 pounds at 1,000 nautical miles.





Titan III-C booster liners built by Roh

On these massive, motor-driven mandrels, Rohr is fabricating the large insulatin
liners for first-stage boosters of the Air Force Titan III-C for United Technolog
Center. Built up through precise application of many plies of uncured, calendere
rubber, the entire unit is encased in nylon and cotton shrink tapes and cured in 15-foo
diameter Rohr autoclaves. Very subtle tapers and convolutions are achieved in th
components to accept the configuration of the engine case. Production of these critical booster liners provides another demonstration of constantly expanding capabilities in many new product areas at Rohr. For information concerning specific Rohr engineering and production know-how, please write: Marketing Mgr., Dept. 21, Rohr Corp., Chula Vista, Calif.

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Technical Countdown

ADVANCED MATERIALS

Magnetic Modulating Material Discovered

A new material—europium orthosilicate—discovered by scientists at IBM's Watson Research Center, Yorktown, N.Y., is nearly 10 times as effective as previously known substances in rotating the plane of polarization of light when subjected to a magnetic field. The strong rotational characteristics of the material may be useful in modulating laser beams. Measurements on the europium compound reported in the *Physical Review Letters* show that its Verdet constant—the rotation per unit of thickness per unit of magnetic field—is 2.5 minutes/oersted/cm at room temperature. The material is highly transparent to red and yellow light and ferromagnetic at low temperatures. It is also easy to handle and chemically stable in normal use.

Martin Builds Materials Test Lab

An ablative materials evaluation facility incorporating high energy solid motors as hot gas generators will be in operation next month at Martin-Orlando. The motor will generate chamber pressures up to 5,000 psi with gas velocities greater than 8,200 fps. Temperatures in the specimen loading area will be in excess of 5,000° F. The work area can accept specimens up to 225 sq. in., allowing the testing of full scale missile components in a particle-free hot gas with a chemical composition similar to air.

Thermal Radiation Properties Sought by NBS

The National Bureau of Standards is developing methods and equipment for obtaining thermal emittance data on materials in the 1400° to 2500° K range. Working standards are available from the Bureau in the 800° to 1400° K range. In the 1400° to 1800° K area, the Bureau is developing rotating specimen technique consisting of a hollow cylindrical specimen of refractory oxide mounted in a furnace equipped with a water-cooled viewing port. Tests with alumina specimens show that temperature gradients have been reduced to workable levels. For temperatures above 1800° K, shallow-holed discs are induction heated in crucibles and measured with optical pyrometers. Further work is in progress to establish accuracy limits with this method. Thermal emittance data at re-entry and engine operation temperatures is vitally needed in a number of programmed space and missile projects.

Avco to make Titan III Thrust Termination Tubes

Avco's Aerospace Structures Div. will produce 196 thrust termination tubes under a $1.78-million contract from United Technology Center for the *Titan III* solid boosters. The tubes will have aluminum honeycomb and stainless steel outer skins with an interior of tape-wound high silica reinforcement. Manufacturing techniques are similar to those used in producing ablative type nozzles. The tubes will be wound on an Avco-designed machine capable of reaching 95% required density in the as-wound condition.

PROPULSION

Cloud Seeding Rocket Developed

A low-cost rocket capable of artificially inducing rain is in development at Rocket Power Inc. The rainmaker would eliminate the costly and elaborate aircraft missions involved in cloud seeding. The silver iodide crystals would be instantly diffused, triggering cloudbursts much more effectively than with aircraft seeding. Another application might be in punching holes in overcasts above airports.

Minuteman Cost Reductions Accepted

Thiokol Chemical Corp. gained Air Force acceptance on a cost reduction item which will reduce *Minuteman* first stage motor manufacturing costs by $1.089 million over the next three fiscal years. The innovation is in the transferring of solid propellant from the mixers to the motor loading area. The Air Force is auditing six more Thiokol ideas which may lop another $401,000 off the project. The entire *Minuteman* program cost savings effort is set at $150 million with Thiokol portion totalling $20 million.

Saturn First Stage Simulator Under Construction

A 12-story, 300,000-lb. steel structure aimed at simulating the first stage of the *Saturn V* vehicle will be built at Martin/Baltimore. The massive simulators will be used to test ground handling and launch and test stand erection equipment designed for use at the Marshall-Huntsville, Mississippi Test Operations and Cape Canaveral *Saturn* facilities.

New Mixer in Operation at UTC

A drive-through mixer facility capable of turning out three tons of propellant "every few hours" will soon be in operation at United Technology Center's processing complex. Premixed fuel is brought to the vertical station in a mixing pot, raised to the mixer's three planetary blades and the mixing process begins. Oxidizer and other ingredients are added remotely during the process. At the end of the cycle, another pot replaces the mixed one, enabling the mixer to operate almost continuously in processing propellant for the *Titan III* boosters.

Hercules To Provide HIBEX Propulsion

Hercules Power Co. announced its selection by the Boeing Co. to develop the propulsion system for HIBEX experimental booster. The HIBEX is designed to generate information for advanced anti-ballistic missile systems and $6 million in funds has been let by DOD to Boeing on the program. Hercules did not disclose the contract dollar amount.

ELECTRONICS

New Diode Detects Infinitesimal Signals

Two electronic functions, photodetection and parametric amplification, have been combined within a single semiconductor diode. The result, say scientists at Sperry Rand Research Center, is a device capable of raising present laser and radar receiver sensitivities by a factor of 100. Called a photoparametric diode, it has already been employed to detect and amplify an optical signal of less than 10^{-9} watt and developers estimate the ⅛-in. long component will be capable of similarly handling power levels down to 10^{-18} watt. Frequency response is from dc to roughly 2 gc, Sperry said, but will be extended to 25 gc.

Emphasis on Space Cryogenics Advances at Linde

by John F. Judge

THE LINDE DIV. of Union Carbide Corp. is moving swiftly into the space cryogenic equipment field—starting with vacuum insulated piping.

The SI-vacuum-insulated piping—designed for efficient transfer of cryogenic liquids—is finding its way into test stands and launch complexes around the country. Linde spokesmen see an increasing market in the missile/space area for the hardware.

In their prime market area, Linde scientists are rapidly transforming slush hydrogen from a laboratory curiosity to a serious contender for operational status. Based on certain concepts, the slush approach to the cryogenic fuel can provide as much as 18.5% in weight reductions for long-term space storage missions.

- **Vacuum transfer**—The insulated pipe, produced at Linde's Speedway plant near Indianapolis, is double-tubed, with the firm's super-insulation providing the heat blockage in combination with vacuum.

The inner pipe is usually fabricated from invar—an iron-nickel alloy containing approximately 36% nickel and having a coefficient of linear expansion of about 1 x 10^{-6} in./in./° C at ambient temperatures. Alternate layers of aluminum foil and glass paper are wrapped around the invar. A strip of getter material is included in this laminate.

The usual insulation thickness is about 0.5 in., though this varies depending on end-use and customer specifications. At pre-determined points along the inner pipe, sets of three supports are installed before wrapping. The supports are made of low heat-conducting material. A stainless steel outer pipe is then installed.

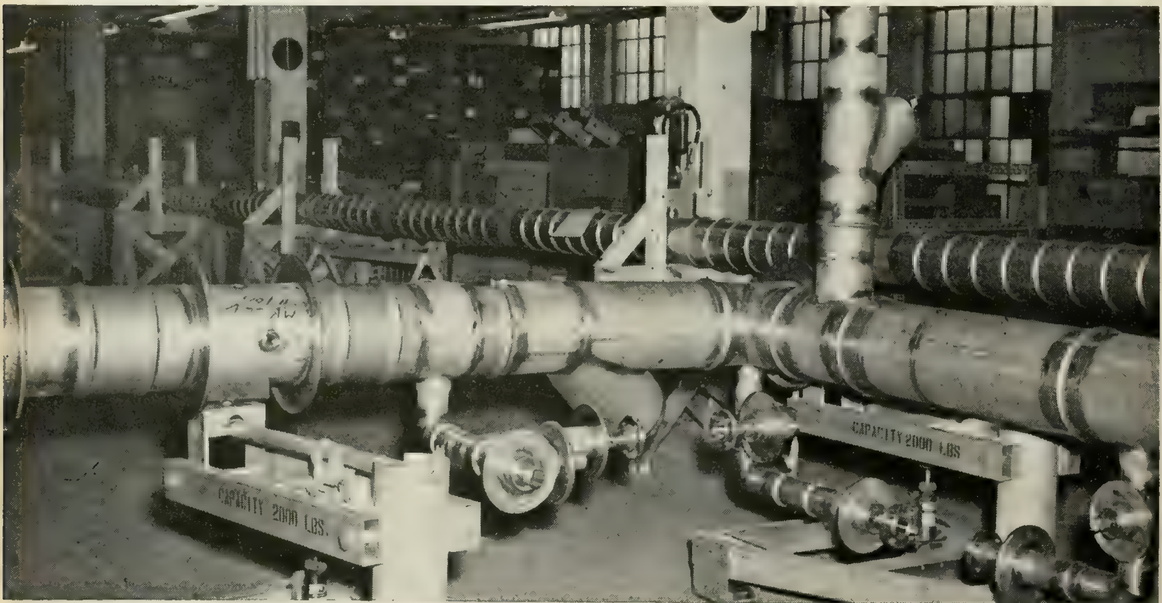
Each end of a given length of pipe—standardized by Linde at 40 ft.—is closed by welding a bellows-type connection to it. The bellows configuration provides a relatively long heat path in the extremely small space between the pipes—while effectively sealing the insulated pipe section.

Linde then evacuates the space between the pipes through a vent previously installed in the outer pipe. In the evacuating process, a pressure plug is inserted in the vent and the final seal is formed by a resin.

The plug incorporates a relief diaphragm with a knife-edge puncturing section. If the inner pipe should leak and pressure builds up in the insulation section, the diaphragm is forced against the knife-edges and bursts, relieving the pressure.

Stringent cleanliness and quality-control measures prevail through every step of pipe construction. In some cases,

COMPLEX SHAPES show design flexibility of Linde's vacuum insulated pipe.



completed sections may be required to hold cryogenics under pressure for specified lengths of time to check against leakage and the insulation effectiveness.

Linde buys all the material for the super insulation, which is handled in a manner similar to the hand-lay-up of reinforced plastic structures. The pipe-winding production machinery is very similar to that used in applying protective wrap to ordinary pipe before installation.

- **On-site connections**—The fabricated pipe sections are joined in the field by welding the inner lines. Linde supplies a joint kit that includes a super-insulation wrap for the welded joint and a bolted fitting to seal the insulation within the outer pipe. When the system is in operation, the joint acts as a cryopump, condensing most of the gas present in the insulation space and creating a vacuum.

Linde's SI-vacuum insulated piping costs about $100 per foot but this can vary depending on the specification and materials involved. There is also a cost difference between straight pipe and complex configurations embodying valves, pumps or other line items.

About 1,000 ft. of various diameters of insulated pipe is being installed at the Aerojet-General *Nerva* facility for liquid hydrogen. Besides this yard piping, there is an additional 2,000 ft. in the test stand.

The F-1 engine test stand at Edwards Air Force Base will use 7,400 ft. of pipe with 198 spool pieces. Rocketdyne's C-5 system uses 1,200 ft. of 2-in. liquid hydrogen transfer pipe. The C-9 test stand at Aerojet-General (*Nimbus*) takes 800 ft. of 2-in. LH_2 transfer pipe. The Douglas *Saturn IV-B* test complex at Sacramento includes 900 ft. of combination yard and stand piping.

Edwards is receiving the last shipment of sections for a mile-long, 6-in.-dia. oxygen transfer line. And Complex 34 at Cape Canaveral will use 1,000 ft. of 6-in. pipe. Complex 34, Pad A will require 1,000 ft. of 6-in. liquid hydrogen piping and 1,100 ft. of oxygen lines. Linde is prime contractor on the former launch complex.

Linde's main problem with the pipe is in installation procedures. Most construction contractors are accustomed to various types of piping, but these are extremely rugged compared to the highly complex and relatively fragile vacuum insulated lines. Handling damage to the latter is common.

Linde is attempting to educate the user while beefing up the outer jacket to withstand greater punishment.

- **Slush into space**—The greater part of Linde work with slush hydrogen is in progress at the firm's Tonawanda, N.Y. facility. R. R. Carney presented the fuel concept as a contender for operational space projects during a recent cryogenics conference held in Boulder, Colo.

Slush hydrogen is a mixture of solid and liquid hydrogen. Its close resemblance to a mixture of snow and water accounts for the name. Not all compositions flow—the maximum solid content for such a mixture is 50% by weight. Slush hydrogen exists in equilibrium with vapor-solid-liquid only at the triple point of 13.8°K and 52.8 mm Hg. (approximately 1.02 psia).

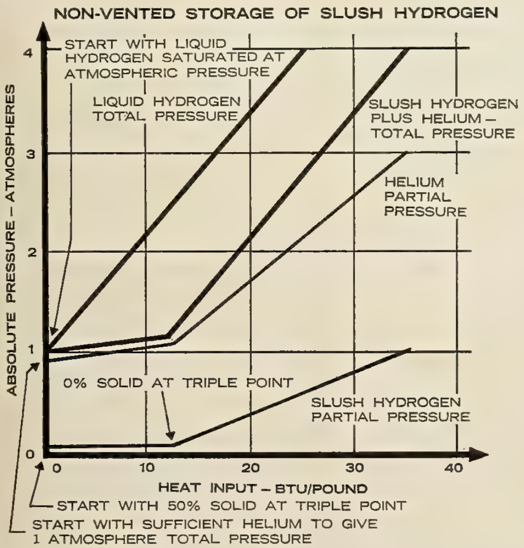
Linde is well into theoretical and experimental studies of slush hydrogen and its production methods. Early data indicates the capital cost of batch preparation equipment will be high compared to operating costs.

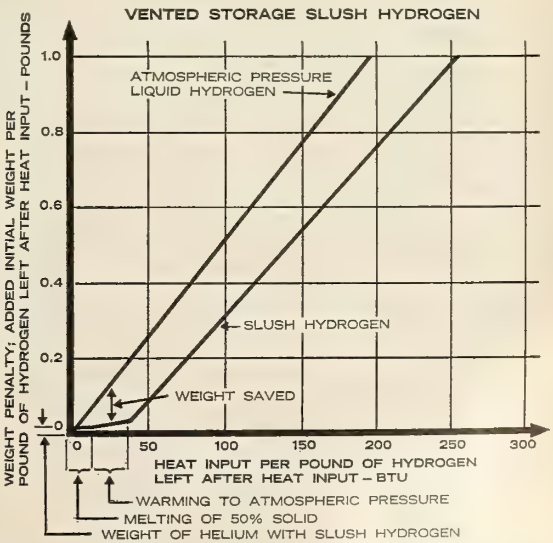
Carney says that large, continuously operating central mass plants will have a distinct economic advantage over batch production at launch sites. Either method would probably involve vacuum pumping of liquid hydrogen.

Carney adds that if the slush is produced at a liquid hydrogen installation, an appreciable fraction of the hydrogen pumped away can be recovered in the liquifier. It may even be feasible to recover a portion of the sensible heat of the vapor in the liquifier, reducing its operating costs.

- **Transporting the slush**—The slush can be transported in the most efficient equipment now being used for liquid hydrogen—with about 0.7% melting of the solid for the same heat leak, which causes 0.1% liquid evaporation. In hard terms, says Carney, a four-day haul in a large, insulated railroad car would cause a drop in the solid fraction from 50% to 40%. This could be upgraded back to the original mixture through a small vacuum pump on the launch site storage tank.

The triple-point equilibrium condition requires that the space booster tankage be pressurized. This could be





achieved with helium at 13.8°K or colder. Transfer through an insulated pipeline could be by pumping or pressurizing the delivery tank.

Since conventional topping is not applicable, the vehicle tanks would have to be well insulated while on the ground. Heat input causes the solid to melt but with no venting of vapor. Instead of topping, an upgrading process might be feasible during ground hold, says Carney.

Carney covered both non-vented and vented storage in his presentation. Both conditions are illustrated in the curves on page 23. Carney based most of his calculations on the assumption that helium is insoluble in slush hyrogen, but the Linde expert says more work is necessary in this area.

• **Loading approaches**—The non-vented storage of slush hydrogen differs in two respects from storing a comparable amount of liquid hydrogen. In the first place, the melting of 50% slush uses 12.5 B.T.U./lb. heat input without an increase in the hydrogen pressure. In addition, 36 B.T.U./lb. are available in melting and warming up to liquid at atmospheric pressure.

Secondly, the helium-pressurization gas loaded on-board to prevent collapse of the tankage is compressed into smaller volumes as the melting and warming process increases the hydrogen volume. This helium compression causes a pressure rise in addition to that of the hydrogen alone, and requires ullage space.

PROPERTIES OF SLUSH HYDROGEN

PROPERTY	TRIPLE POINT SOLID HYDROGEN	SLUSH HYDROGEN 50% SOLID	TRIPLE POINT LIQUID HYDROGEN	TRIPLE POINT HYDROGEN VAPOR	ATMOSPHERIC SATURATED LIQUID HYDROGEN	ATMOSPHERIC SATURATED HYDROGEN VAPOR
Temperature—°K	13.8	13.8	13.8	13.8	20.3	20.3
Pressure—psia	1.02	1.02	1.02	1.02	14.7	14.7
Density—lb./ft³	5.41	5.09	4.81	0.0078	4.42	0.084
Specific Volume—ft³/lb.	0.185	0.196	0.208	128	0.226	11.9
Enthalpy—BTU/lb.	4.55	17.06	29.58	223.2	52.61	244.4
Heat Input Above 50% Solid—BTU/lb.	—	0	12.52	206.1	35.55	227.3
Heat Input Above Atmospheric Saturated Liquid—BTU/lb.	—	—	—	—	0	191.8
Heat Input Advantage for 50% Solid Slush Hydrogen—%	—	—	—	—	—	18.5%
Specific Volume Below Atmospheric Saturated Liquid—ft³/lb.	0.041	0.030	0.018	—	0	—
Volume Advantage for Slush Hydrogen—%	18%	13%	8%	—	0	—

The non-venting curve illustrated is an arbitrary example of tankage with a four-atmosphere working pressure, says Carney. This example requires the same tankage volume per pound of slush or liquid hydrogen. But the slush stores much more heat for the same pressure rise, allowing a much longer mission or less insulation weight—or lower working pressure with a resultant reduction in tank weight.

The vented storage example used to produce the curve is for a low-working-pressure tank in which the absolute pressure vent device is set at 760 mm Hg. during fueling, ground hold and space storage. Weight savings with slush are obvious from the curve.

To emphasize the effect of the helium that must be loaded with the slush hydrogen, Carney presented the weight loss on a reciprocal basis—propellant weight required at lift-off to leave behind 1 lb. of hydrogen after the heat input has taken place. The changing tankage weight is not included.

Carney says the weight loss during melting of slush hydrogen and warming to one atmosphere is very low and almost entirely helium. It would be advantageous to restrict the heat input during the mission to this amount, preventing any appreciable weight loss.

Linde is exploring several new areas with the insulation concept. Super insulation was first applied to storage dewars, then truck and railroad tank car conveyors, and finally to launch site and test stand storage tanks.

The latest development in this evolution is the application of "quilted" super insulation to large cryogenic vessels. Developed for field-erected tanks, the quilted insulation has been applied to a 105,000-gallon liquid hydrogen weigh tank at Aerojet-General's Nimbus Station facility.

The concept can be extended to large barges and space simulator cryopanels.

The 1,050 lbs. of quilted super insulation used on the Aerojet tank requires 240 lbs. of liquid hydrogen in the cool-down process. If powder insulation were used, 109,000 lbs. of perlite would be needed for equal thermal performance with a cool-down liquid hydrogen cost of 24,000 lbs.

The tank was designed as a primary load calibrating device, and the inner container had to be unimpeded in its vertical motion to give a true weight indication.

• **One week installation**—The tank was erected in the field, but Linde's normal insulation fabrication process could not be used. In addition, the insulation installation schedule called for a start-to-completion period of seven days.

Linde's answer was to sew the entire set of aluminum foil layers and separator sheets to plastic sheets while avoiding compression. Blanket sections were fabricated in the factory and shipped to the site. There a team of Linde experts covered the tank with the blankets in a quilt pattern.

Adjacent blankets were butted and sewn together. Joint provisions and overlap were previously provided in the design of each blanket.

The Aerojet tank is expected to be operational at the *Nerva* site early in 1964. The specification calls for a maximum heat leak of 0.45% of the total hydrogen capacity per day—or 2,220 B.T.U./hr. Linde expects the total heat leak to reach only 0.3% of total capacity per day, to 1,480 B.T.U./hr.

The particular insulation used is Linde's SI-12 super insulation—a 13-layer/in. covering of aluminum foil and web-type glass fiber mat.

In another area, Linde cooperated with NASA's Lewis Research Center to investigate the effects of a compressed multi-layer insulation system on a liquid hydrogen rocket.

The question was directed at the efficiency of such insulation after being under compressive forces for a period of time. To insulate a vehicle with the super-insulation concept necessarily involves the elimination of the heavy-walled vacuum jacket and replacing it with a lightweight but impermeable flexible jacket.

The researchers applied the insulation to a 150-gal. cylindrical cryogenic tank and then tested under atmospheric compression of the insulation. Further tests were conducted as the compressive force was lessened, simulating the approach to pressures outside the Earth's atmosphere.

Shorn of the experimental defects, the researchers concluded that the application was feasible and that a compressed multi-layer insulation would function efficiently after leaving the Earth's atmosphere.

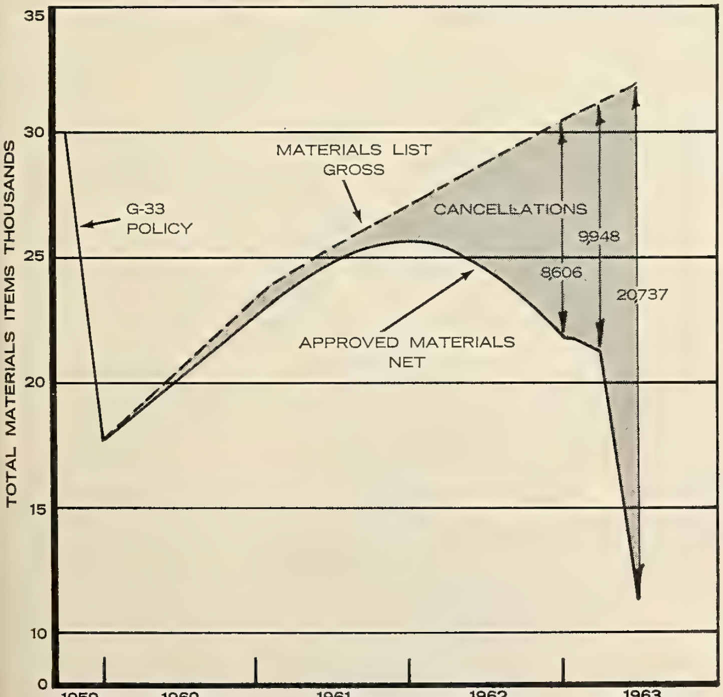
A vacuum can be maintained in such insulation during ground hold and boost through the atmosphere. Such a flexible jacket insulation might have to be protected with a shroud during launch, but the compressive effect of the atmosphere on the evacuated insulation space will not seriously affect its usefulness in space-storage applications. ■

management

Martin Cuts R&D Costs Through Standardization

Designers in advanced projects can get standard 'exotic' materials under program that has saved over $3.5 million

by William Beller



Trends in Martin's Materials Standardization

WHEN A LARGE CORPORATION has several divisions working in the missile/space field, money can be saved without loss of divisional autonomy if a serious but simple standardization program is used.

This is true even if the company's work is mostly research and development, the Martin Co. has found.

Modern standardization itself has moved into the research and development field. Because of this, Martin designers are able to call for exotic but "standard" materials and processes needed for advanced projects.

The Martin Co. last year saved $225,000 by standardizing its computer programs. The company saved $2 million without inconvenience to its engineers by reducing the numbers of materials items, mostly in wire and cable.

In 1962, a sampling of savings to Martin was $3.5 million. The full amount, believed to be several times that amount, has not been documented.

Only $400,000 was spent on the standardization program, which is directed by Paul A. Piper, who has no staff. All the work is done by employees responsible to their own divisions. Piper is chairman of the executive committee that sets standardization policy and sees that it is put into effect.

Piper claims this is a field where research can show short-term gains, unlike the situation that normally exists in a research project where the outlook is the long-term view.

The best example of the way Martin standardized is in the materials field. If things had gone as they were going in 1960, the company today would have more than 30,000 items on its approved materials list; instead, Martin has less than a third that number.

At the beginning of 1960, the various Martin divisions in many instances were ordering the same materials by different designations from the same suppliers, losing the economy of bulk buying. New materials, meanwhile, were being added for the R & D effort going on, compounding the problem.

● **Controls established**—A central controls group was set up in Baltimore about that time to act as a drag on new materials purchases. It suggested materials already in stock or on the standards list, Piper said.

Martin also found it was not necessary to select metal sheet in all sizes, grades and gages. It was possible to order only a quarter of what is available and still do an efficient job. The materials list was down to 22,000 items by the first of this year.

"Then in June, we had a one-week meeting and threw out 10,000 more items," said Piper. "The active approved list went down to 11,300 items.

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AIR FORCE SYSTEMS COMMAND has immediate openings for engineers and scientists in these areas.

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AEROSPACE ENGINEERS—To assess and analyze foreign competency in such areas as aero-research and development, power plant and propulsion development, weapon systems and warfare systems.

ELECTRONIC ENGINEERS—CONTRACT ADMINISTRATION—To monitor Air Force research, development, testing or maintenance contracts pertaining to aerospace electronic applications i.e. ground and airborne radar, navigation equipments, inertial guidance, communications, instrumentation.

INSTRUMENTATION ENGINEER—Evaluates range contractor instrumentation proposals to meet test requirements by using telemetering means which include HF, VHF, UHF transmission and receiving equipment, complex antenna systems, recording systems.

AEROSPACE ENGINEER—Accomplish, promote and sponsor basic research in the areas of Air Force interest in the field of fluid motion, emphasizing, but not limited to hypersonic phenomena. Analyze and evaluate fluid dynamic research proposals.

ELECTRONICS ENGINEER—Strong background in development, fabrication, installation, maintenance and experimental operation of large radar sites. Should possess ability to recognize deficiencies and incompatibilities in plans.

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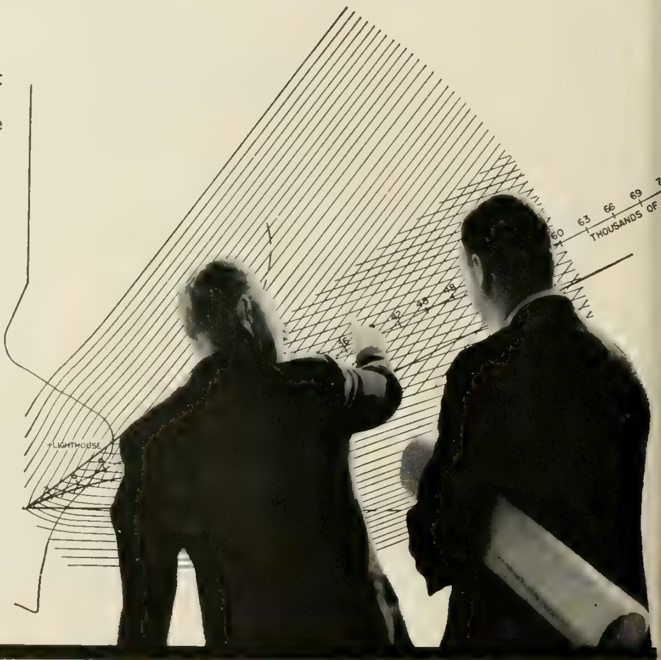

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"It's a constant process of screening items to keep them up to date," Piper explained. "We don't want to limit designers unnecessarily to what they've always used simply because they've always used them.

"Take, for example, wire and cable," Piper suggested. There are 2,000 to 3,000 different types and gages of wire. A designer may pick out 100 ft. of one type. Procurement orders 1,000 ft., which is the minimum, and eventually may throw out the remainder.

But if the designer is limited in the materials he can choose, he will use a smaller number of items. These, in turn, will be specified more frequently, and procurement can take advantage of bulk buying and reap the benefits of little or no scrap—at the same time satisfying engineering requirements.

- **Universal programming**—Although computers were not initially standardized throughout the divisions, they now are. The same programming methods are used throughout the company. And there are two books giving abstracts of programs, so that an engineer in one division can adapt, if possible, the program already worked out in another division and ask for the tape.

Last year, Martin exchanged 76 basic programs. It costs an average about $7,600 to set up a program on a digital computer, so the savings were appreciable. In the first six months of this year, 76 more programs already have been exchanged, so the idea is expected to pay off even more as the number of programs is increased.

In one instance, when the 7094 computer was tied up in Denver, Baltimore took some of the overload through a data link. In this way, Denver was able to postpone renting another 7094 for about five to six months, thereby saving $225,000—the difference between the cost of the data link and the rental.

- **Committee action detailed**—The chief engineer of each Martin division is on the standards executive committee: from Space Systems, Canaveral, Denver, Orlando, Nuclear and Electronic Systems & Products. If there are any problems, these men have the direct power to iron them out.

When the executive committee was formed in 1961, it met three times in the first four months. Now, there is only about one such meeting every six months. Most of the difficulties have become routine. Piper says he can easily handle them by telephone or by personal visits without bringing them to the executive committee.

Practically all standards start in a divison. They are then reviewed by a standards subcommittee to see if they can be used throughout Martin. They are modified, if necessary, and then adopted.

Subcommittee decisions are not made arbitrarily. Each member represents one of the Martin divisions and has a strong voice in formulating standards and in proposing new ones. Each of the company's seven subcommittees meet about three or four times a year. If any of them has a problem it can't resolve, it gives it to the executive committee.

Active subcommittees are: drawing procedures, engineering practice, material specifications, standard parts, process specifications, engineering computational procedures and electronic packaging.

- **Management enthusiasm**—The standards program would have been impossible without the active cooperation of top management. Always a proponent of standardization, William Bergen, Martin president, issued a directive calling for a materials identification effort, resulting in a sizable reduction of the materials list. He later issued a policy directive stating that there should be an overall interdivisional standardization program. From here on, the job was implementation.

J. P. Butterfield, then executive engineer in general offices, personally went around and enlisted the support of the general managers of all the divisions, and chief engineers. This led to the formation of the very effective standardization executive committee.

Piper does not believe in setting up a central body to do standardization work. "If it is done this way, the job gets away from the working level," he pointed out. On the divisional level, though, people form the standards, use them, coordinate them and even upgrade them.

Beyond the direct economic benefits, standardization can reduce lead time because of the presence of a good body of standard items saves designers time and confusion.

"We can prove reliability," said Piper, "because the more you use proven things, the more you avoid unknown troubles." He added: "I always buy one-year-old cars, after somebody else has taken the bugs out."

For *Titan III*, for example, standards made a highly selected list of materials and processes. Martin is now extracting many of these "standards" for *SPRINT*.

"Denver did a wonderful job working up a welding process for electronic connections. We estimate we saved $40,000 picking up this Denver work and using it in Baltimore.

"One division takes over a job and concentrates on it and then other divisions pick it up. Through this exchange, we avoid duplicating efforts and reap the economic benefits."

- **Standardizing the standards**—Wherever possible, Martin uses government standards and industry standards. Then the company tries to eliminate unnecessary items from these lists and the remainder forms part of Martin standards.

The problem is more difficult when it comes to standardizing on processes. "We consider them joint developments of manufacturing, quality control and engineering," said Piper. When the processes are signed off, quality control will also have good guidelines for evaluating the efficiency of the processes of Martin subcontractors. Although the company does not demand that subcontractors use the standard process, Martin does demand that the processes be qualified as equivalent.

Standardization is sometimes called "documentation of the obsolete." "It's not so here," Piper told MISSILES AND ROCKETS. "Even in R & D, standardization can be a great help. Printed circuit boards, printed circuit processes, sealing and potting materials, connectors—all lend themselves to standard processes."

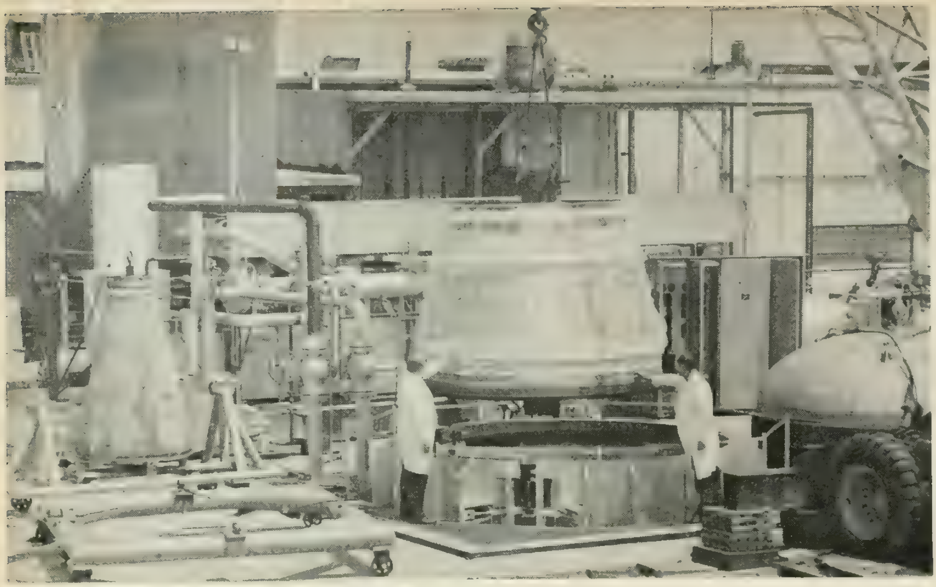
Through the subcommittee meetings, Martin urges its divisions to devise standards in advanced components, such as circuit elements. It was found, for instance, that repetitive circuits such as logic elements can easily be standardized. "We've found five or six highly repetitive ones in our guidance and other electronic systems," Piper said.

- **Future fertile areas**—Martin is looking into a standard process control for thin-film integrated electronic circuits. Here the company is trying to anticipate the changing state of the art.

"We wish we could turn back the clock," said Piper, "and standardize conventional electronic techniques. We started too late in the game, but we are trying to do the job on advanced electronics."

He explained that Martin wants to tie in much more closely with ongoing research so that the results of this research can be given to designers, and lead time can be cut. "This is one of the reasons we are looking into radiation-resistant circuits—to see if we can come up with some standards and anticipate engineering requirements," said Piper.

Martin, at the same time, is doing its conventional standards work. But standards has become a dynamic field, with a future extending far beyond the old bookkeeping regime to one of R & D, consultations, and even basic research. ■



AFTER CURING at high pressure, nozzle section is lifted from new hydroclave installed by HITCO to meet large booster component needs. Pressure dome is at far right.

space support

Huge Hydroclave Works On Massive Titan III Exit Cones

HITCO's $250,000 installation uses economical tooling, provides high pressures necessary for dense reinforced plastic parts

THE WORLD'S LARGEST hydroclave-autoclave—132 in. across and 170 in. deep—is the key to production of the massive exit cones in the *Titan III* booster at H. I. Thompson Fiber Glass Co., Gardena, Calif.

The firm spent more than $250,000 for the single pressure-molding unit, which is easily capable of handling any reinforced plastic component for launch vehicles up to and including 156-in. diameter solids.

HITCO shares the production contract on the *Titan III* nozzles with the Tapco Division of Thompson Ramo Wooldridge. Company spokesmen claim the investment in the huge hydroclave was one of the deciding factors in the contract award.

Before the hydroclave was built, designers of sub-scale nozzles and insulative and ablative components for large rockets were somewhat concerned at the lack of large-scale processing equipment. This situation might force the adoption of less desirable molding techniques—in terms of product density, reliability and usable production factors.

The problem was severe enough to foster several test programs aimed at evaluating new methods—such as prefabricating segments for later assembly into large units.

HITCO's investment in the huge hydroclave relieved the pressure somewhat, but the unit will not handle hardware that will develop from some of the more advanced large solid concepts under discussion. Donald Slocum, program manager, says the installation will adequately meet 156-in. requirements and any smaller size.

The hydroclave can be modified to take larger parts by expanding the pressure vessel's diameter and length through flaring the top of the unit with a frustum. The extremely high heater-cooler capacity will permit this without loss of pressure capability.

- **Refractories not practical**—The main reason for the emphasis on laminates in large nozzle construction is the very limited material selection available. Weight, difficulty in fabrication and scarcity in the required dimensions almost rule out the use of refractory metals.

In the throat section and surrounding areas, laminates of graphite cloth or tape bonded with resins are used. Moving toward the exit cone, the composite structures use carbon tape and then silica wrap. Glass fiber is employed beneath the outer layers and the whole nozzle assembly fits into a steel shell before being attached to the rocket.

The hydroclave is an integral tool that permits the use of hydraulic pres-

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etails of positions and locations of assignments are provided on the next page. Check for your specialty, then l out and mail the attached Professional Placement Inquiry form, or write to Mr. R. M. Smith, Chief of Professional acement and Personnel, Dept. 130-90, General Dynamics | Astronautics, 5863 Kearny Villa Road, San Diego, alifornia 92112.

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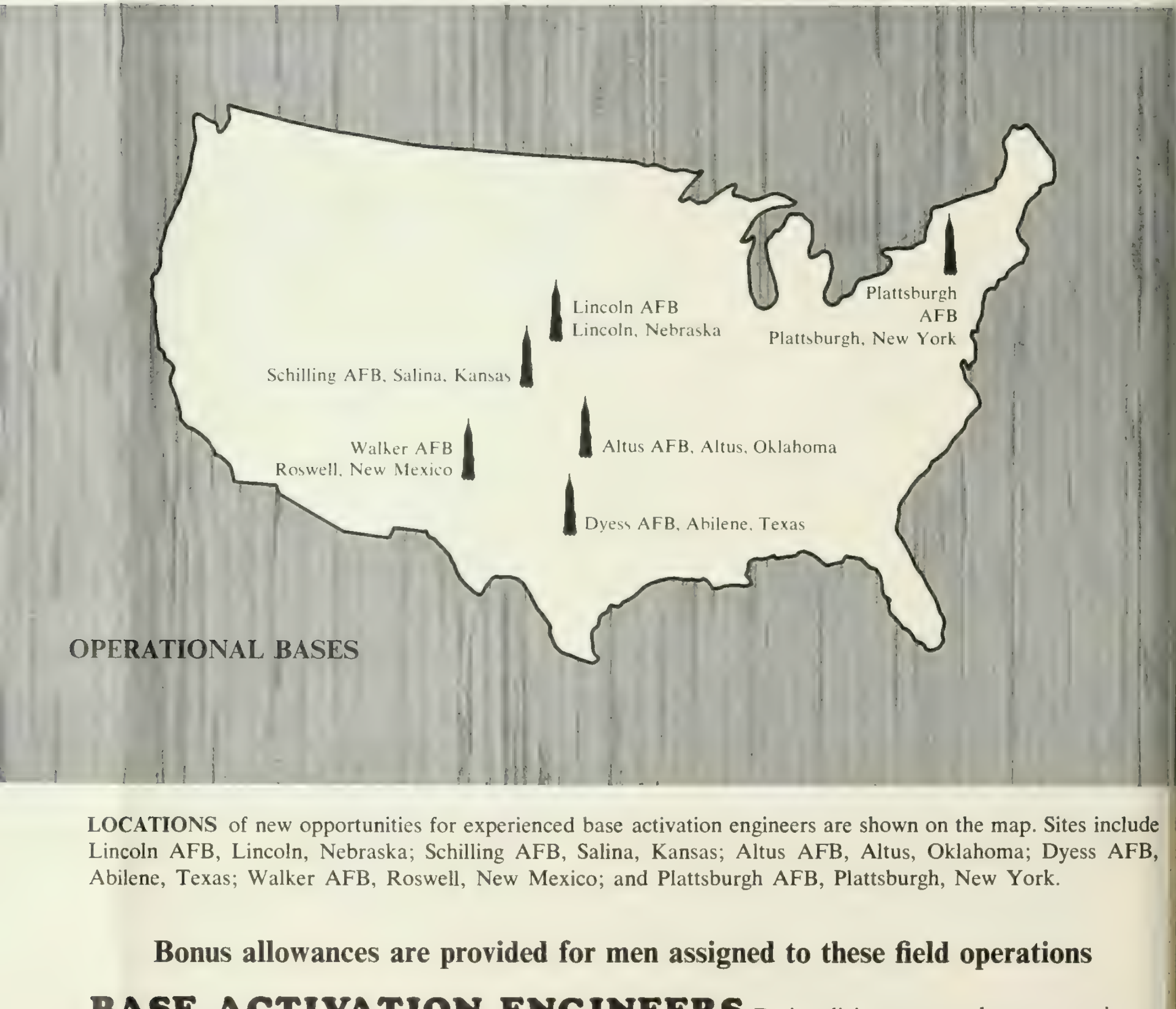
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OPERATIONAL BASES

LOCATIONS of new opportunities for experienced base activation engineers are shown on the map. Sites include Lincoln AFB, Lincoln, Nebraska; Schilling AFB, Salina, Kansas; Altus AFB, Altus, Oklahoma; Dyess AFB, Abilene, Texas; Walker AFB, Roswell, New Mexico; and Plattsburgh AFB, Plattsburgh, New York.

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sure—in addition to a fluid medium—to mold these complex plastic parts. These devices supply the high pressures normally associated with compression molding but with less costly tooling. Present hydroclaves are capable of exerting pressures ranging from a nominal 1,000 psi to 3,500 psi uniformly across the surface of a plastic part.

Even 3,500 psi is not regarded as a maximum since the only real limitation involved is the physical size and strength of the hydroclave itself.

The autoclave uses gas pressure—up to 300 psi—to form parts, and provides the starting place for hydroclave pressures. Another essential difference between the two pressure methods is that heat is transferred to the part being fabricated at a much faster rate in the hydroclave than in the autoclave—but not as fast as with matched tools.

- **Dense parts result**—The higher pressures available in hydroclaving yield extremely dense plastic parts and the method is the only presently proven approach capable of maintaining fiber orientation in the workpiece, says Donald M. Hatch, engineering manager, Aerospace Division.

Oriented fiber tapes or stacked fiber plies are used almost exclusively in hydroclaved parts. This differs from the chopped fibers or bulk materials that form the prime raw stock in compression molding.

Hydroclaving leads to superior molding, says Hatch, because the angle of oriented fiber layup can be controlled precisely. This is not true in compression molding, in which there is always the danger of resin flow in the die.

Such movement of reorienttion of material from one position to another can result in parts of unequal and undesirable density.

In plastic components destined for missile applications, the orientation cannot be disturbed during the cure cycle—and hydroclaving will maintain orientation even with materials of unusually high flow characteristics.

While bulk or chopped fibers have not been used for hydroclaved parts, Hatch says these molding materials are receiving serious consideration. Bulk materials can be used, but fabrication methods for them are still being developed.

Bulk materials are cheaper then oriented fabrics and are generally easier to pre-form and mold. But the major advantage—says Hatch, is that if used in the hydroclave, the tooling costs would be reduced even more. The tooling cost decrease in moving to hydroclaving from matched dies is substantial.

Hatch says a second reason for the increasing emphasis on hydroclaving is that it sometimes yields a better end product in spite of lower raw material quality.

In some cases, the material may have marginal flow, resin content and volatiles, and will require curing pressures in the 1,000 to 3,000-psi range. Low-pressure curing with these conditions would result in varying densities and physical properties.

- **Resin-flow consideration**—Hatch says it is axiomatic that the low pressure that determines high-flow, high-volatile materials will assure flow of the resin. While this may be satisfactory for medium and low quality parts, it just will not suffice for extremely high-quality parts because the volatile content molded into the part must be reduced to get the highest density.

Reducing volatile content also reduces resin flow, and makes it much more difficult to re-arrange the resin within the fiber structure.

The male or female tooling for a hydroclaved part is more economical than the matched dies in compression molding, but it takes somewhat longer to produce a hydroclaved part. This is because of the time-consuming and complicated layup procedure and the care needed in placing the part in the hydroclave.

With reinforced plastic components growing larger and longer, the hydroclaves available will soon be too small. Critics often point to the immense cost of building huge hydroclaves capable of handling rocket components up to and beyond the *Nova* class, but one HITCO spokesman refutes this contention.

- **Materials costly**—HITCO has found that the raw materials for hydroclaved parts are extremely costly—far more than is commonly realized. But a very limited production run, even as low as 10 parts, will justify equipment costs.

Hydroclaved plastic parts are produced by laying up the resin-impregnated fiber on a male mandrel in some oriented fashion. If the part is conical and slated for an ablative structure, the material is oriented parallel to the axis. This exposes the end-grain to a hot gas stream, and end-grain exhibits the highest resistance to surface ablation.

If the part is structural, the fibers are oriented parallel to the surface of the part to pick up the longitudinal loads—or any loading in the direction of fiber layup.

The layup and tool are covered with a flexible envelope and placed in a pressure vessel. Hydraulic pressure is exerted on the part surface during the cure cycle. The part is then disassembled and removed from the mandrel. After some small detail cleaning and machining, the assembly is packaged and shipped to the customer. ■

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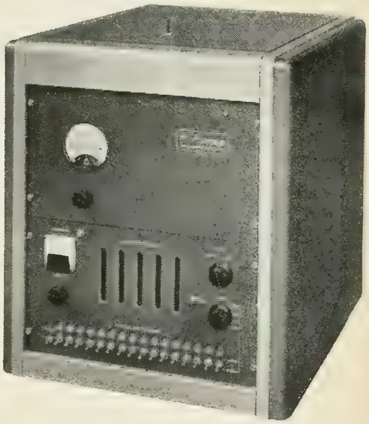

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Military Sees Promise In New Adaptive Space Array

by Michael Getler

BUFFALO, N.Y.—Development of a lightweight, low-power satellite data transmission system using adaptive phase-array techniques could pave the way to secure, rapid transmittal of information from military satellites to ground stations.

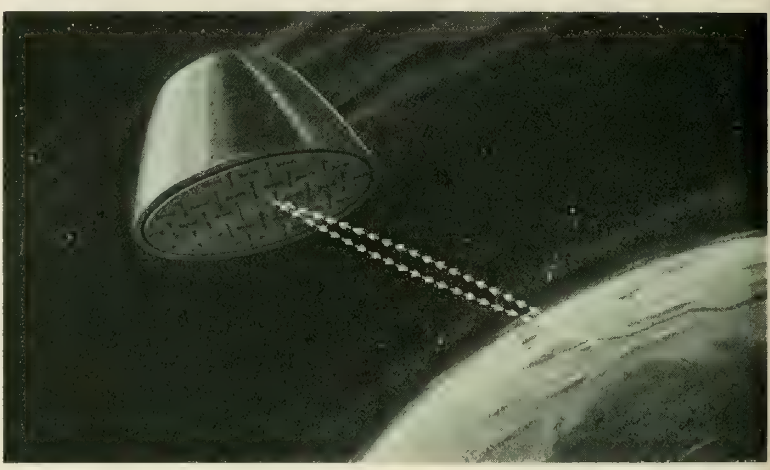
System development, carried out by the Sylvania Electronic Systems Div. facility here, has been supported by the Air Force's Avionics Laboratory, part of the Research and Technology Div. at Wright-Patterson AFB, Ohio.

Air Force officers, expressing "much confidence" in the technique, say there are "tentative plans to fly the system at a later date." A feasibility model has been developed and is under test by the Air Force, but "this unit probably will not be flown." Flight equipment has not yet been fabricated.

The all-solid-state system, as it is now conceived, could fulfill the role of a one-way space-to-ground data link for a wide variety of military satellites, supplying data accumulated by satellite sensors on receipt of ground command. With some modification—addition of demodulation equipment—it also could serve as a communications relay in a two-way link between ground stations.

• **Heart of technique**—Key to the system's effectiveness is the retro-directive phase array. Essentially, steering information for the spaceborne array is derived directly from the ground command signal. There is no physical movement of satellite or antenna, nor is there any of the on-board steering equipment generally associated with more conventional antenna arrays.

The Sylvania array actually consists of two sub-arrays, one for transmitting and one for receiving. The two arrays, each containing 200 elements, are intermeshed—connected by 200 tunnel-diode amplifiers. Use of the small, solid-state tunnel-diode amplifiers, which offer inherent radiation damage resistance, in combination with two sub-arrays, also avoids bilateral amplification problems associated with these devices when used in more conventional arrays.



The transmitted ground command tone, received by individual array elements, is amplified—20 db by single-stage amplification, 40 db by two-stage—and fed to other elements in the transmitting sub-array. Connections are arranged so that the proper phase and relationship of the received signal is preserved, thereby automatically providing steering information to the resulting transmitting beam.

Formation of a highly directive beam in this manner—avoiding the weight, power and programming penalties associated with beam pointing in other systems—in combination with inherent efficiencies of the amplification scheme, leads to a high-gain, wide-band system that can be installed in power- and weight-limited vehicles.

For example, operating at 5,000 mc, an 8-deg pencil-shape beam formed by a 20-x-20-in. array would exhibit about a 25-db gain. The tight beamwidth also assures increased communications security and decreased susceptibility to stray RF interference or jamming.

• **Other advantages**—A complete system, including power supply, using roughly a 2-x-2-ft. array, would weigh about 40 lbs., Sylvania says. The system is shallow, only about 6 in. deep.

Use throughout of strip transmission line packaging for integrated circuit elements contributes to size and weight reductions.

Power requirements for a system operating at a few thousand miles altitude, with enough bandwidth to carry the equivalent of a color TV channel, would be under three watts, Sylvania says. The system is said to be capable of operating from "a couple of hundred miles to about 10,000 miles." Some of its advantages would begin to disappear when used at synchronous altitudes, the firm reports.

Array elements, in effect, operate independently, allowing the system to retain to a major degree the ability to operate effectively even in the face of serious degradation to a large portion of the antenna elements. Sylvania reports that even if half the elements were inoperative, only about 6 db in gain would be lost.

• **Comsat potential**—Configured with demodulation equipment, the system could also provide multiple-access capability, acting as a communications satellite linking two stations or pairs of ground stations.

Scientists point out that choice of the number of beams which can be formed by the system involves a host of basic system weight, size, power and performance trade-offs.

The feasibility model developed by Sylvania for the Air Force includes only nine tunnel-diode transceivers and operates at 1,550-5,200 mc at S-band. ■

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Researcher Proposes 30-day Oxygen Tests

TWO-WEEK TESTS exposing men to the 100% oxygen environment proposed for the first *Apollo* crew should be extended to one month, says a leading medical research organization.

Dr. Emanual Roth, chief researcher in the Aerospace Medicine and Bioastronautics department of the Lovelace Foundation, has concluded that although 100% oxygen seems safe for 14-day missions, the symptoms reported in tests conducted by Republic Aviation Corp. (M/R, May 6, p. 14) indicate that "14-day studies are cutting it too close."

The Republic laboratory report showed that "oxidative anemia" occurred in most of the 28 men tested. However, Roth said his feeling was that a "sensitizing agent" was involved. The men's susceptibility might have been heightened by a slight mercury poisoning from broken thermometers, or oxidation products from plastic insulating material of the pipes carrying liquid oxygen.

Industry observers have voiced some criticism over the Lovelace report because although it was written Jan. 4, it has just been released by NASA's Office of Aerospace Medicine. Dr. George Knaupf, acting director of the office, writes in the foreword that it has been under review by the NASA staff and leaders in the scientific community.

- **News needs**—The report urged that the following areas be investigated:

—*Free radical chain reaction mechanisms in man*—Much work is needed on the molecular basis of oxygen toxicity.

—*Oxygen toxicity in animals*—If other toxic, sensitizing, or even viral factors are key intermediates in causing oxygen toxicity, these are just as important as "pure oxygen toxicity."

—*Human oxygen toxicity*—The Republic studies should be repeated with no possibility of mercury or plastic toxicity for 30-day periods. All subjects should be closely observed until the last symptoms disappear, and then intermittently examined for the rest of their lives.

—*Requirement of inert gas*—Low nitrogen studies should be followed up, and the possibility of other gases as a brake to atelectasis should be investigated.

—*Oxygen and atelectasis*—Experiments on methods to avoid atelectasis under high g-loads should be conducted.

—*Oxygen and lung blast*—Effects of

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With the development of Nitroplastisol (along with other major propellant systems) Lockheed Propulsion has now assumed a strongly competitive position in solid propellant technology. Constant experimentation with unusual ingredients is carried on in Company-funded research programs as well as under government sponsorship. Research for improving production propellants goes on 'round the clock.

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low-density, high-partial-pressure oxygen and low nitrogen on the total body in air blast (such as by meteorite puncture of the cabin) should be studied.

—*Oxygen and relief of fatigue*—Investigation is needed on the idea that high-partial-pressure oxygen levels decrease fatigue.

—*Oxygen and space radiation*—Study of the possibility that high oxygen percentages may increase sensitivity to radiation should be pursued further. Some preliminary work has been done at Republic Aviation.

—*Drugs and oxygen toxicity*—Current emergency drugs carried on spaceflights should be screened for possible complicating effects.

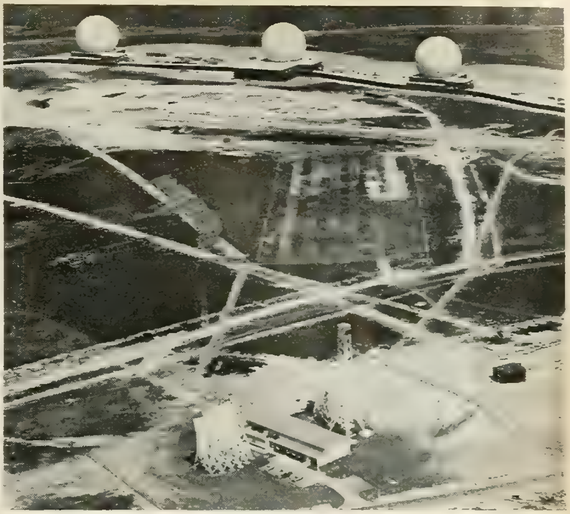
The Lovelace report discusses almost all the available literature on 100% oxygen and evaluates each experiment in terms of how valid the results are in indicating oxygen toxicity. Knaupf writes that scientists reviewing the report had varied opinions about the interpretation of the data compiled, but there was satisfaction with the level and scope of the research that went into it.

The Foundation is working on three more studies in the series—Fire Hazards in Space Cabins, Physiological Factors in Selection of Space Cabin Atmospheres, and Engineering Tradeoffs between One- and Two-Gas Systems.

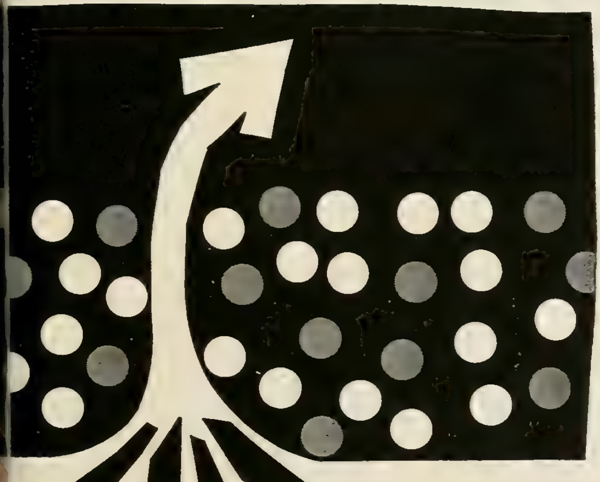
The studies are expected to clear up —once and for all—the question of whether the 100% oxygen environment should be be used for the *Apollo* mission. While NASA doctors are convinced that it is safe, a number of industry doctors have opposed the decision (M/R, May 6, p .14; May 13, p. 15).

All NASA study contracts for longer-duration manned missions call for two-gas systems, and the NASA *Biosatellite*, which will use cellular-level experiments and small animals to investigate the space environment, will have a two-gas life support system. ■

British Site For BMEWS Is Activated



AERIAL VIEW of BMEWS Site III, Fylingdales Moor, Yorkshire, England shows three radomes facing north and east to cover the North Sea. Sept. 17 activation of the site completes the warning system.



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Mergers and Acquisitions

Garrett Corp. board of directors has recommended rejection of an offer by Curtiss-Wright Corp. to buy 700,000 shares of Garrett common stock at $50 per share. The board told Garrett stockholders, "if Garrett stock is a good investment for Curtiss-Wright, it should be an even better investment for the Garrett stockholders." Curtiss-Wright had viewed as "favorable" the prospect of buying the stock. Final decision is yet to come from Garrett stockholders. . . . *Litton Industries, Inc., Beverly Hills, Calif., has agreed in principal to purchase the assets of Clifton Products Co., Inc., Clifton Heights, Pa., producer of electronics for missile/space and aviation applications. Acquisition is subject to final approval of Clifton directors and shareholders.* . . . Roylyn, Glendale Calif., designers, developers, and fabricators of fluid and electrical system components for the missile/space, aircraft, and undersea fields, has merged with Airaterra to form Roylyn, Inc. Airaterra formerly marketed Roylyn products.

New Firms and Divisions

Ransom Electronics has been formed in San Pedro, Calif., to manufacture solid-state digital equipment and modules for industrial, commercial, and ground support applications. . . . *Infrared Industries, Inc., Santa Barbara, Calif., has established a new Optical Systems Div. to make advanced systems as well as commercial optical elements.* . . . The Amphenol Connector Div. of Amphenol-Borg Electronics Corp. has changed its name to Amphenol to avoid implying "a product limitation which does not exist." In addition to manufacturing electrical and electronic connection devices, Amphol has for years been a major supplier of missile/space vehicle cable harness assemblies, programming boards, computer memory cores and interconnection module packages.

International

Varian Assoc., Palo Alto, Calif., is moving its international headquarters from Palo Alto to Zug, Switzerland, to provide closer communications with VA personnel overseas. The move is part of a general international expansion of the company. . . . *Akashi Seisakusho, Ltd., Tokyo scientific instrument manufacturer, is expanding activities in the Western Hemisphere through its factory affiliated corporation, Hardco Scientific Corp., Cincinnati. Hardco is establishing sales and service facilities throughout the U.S.* . . . Fairchild Space and Defense Systems, a division of Fairchild Camera and Instrument Corp., has appointed Technologica de Automacion, S.A. (TECUSA), Barcelona and Madrid, as Spanish sales representative for the firm's aerospace systems and equipment for reconnaissance and mapping, visual data production, communication, guidance, control and ground support.

Industry Facilities

Douglas Aircraft Co., Inc., is completing construction of a new Space Systems Center at Huntington Beach, Calif. The 35,000-sq.-ft. building is due to open late this year. Plans are for the Center to be expanded to accommodate almost every aspect of space research and development. . . . *The Computer Div. of Packard Bell Electronics, Los Angeles, has begun construction in Santa Ana, Calif., on a 75,000-sq.-ft. headquarters building. The building will house research and engineering, manufacturing, marketing, and administrative operations. The division makes data processing systems and equipment for missile/space and industrial markets.* . . . Texas Instruments, Inc., has moved its Washington, D.C., sales offices to a new, enlarged location in the Universal North Building, 1875 Connecticut Ave., N.W. . . . *Advanced Scientific Instruments, a division of Electro-Mechanical Research, Inc., Sarasota, Fla., has announced plans for expansion in the Minneapolis area. ASI, which designs and manufactures digital computer systems for scientific and engineering fields, will move this month into a 47,000-sq.-ft. plant in Bloomington, Minn.* . . . Ion Physics Corp., Burlington, Mass., has expanded test facilities with the addition of a dual-tank, 135-cu.-ft. vacuum chamber for testing large components or assemblies. IPC helped design the facility for use in development of advanced propulsion and auxiliary power systems for spacecraft. IPC is a subsidiary of High Voltage Engineering Corp.

Company Representatives

Hasse & Assoc., Minneapolis, has been named as a sales representative by Deltime, Inc., a subsidiary of Sealectro Corp., Mamaroneck, N.Y. Hasse will operate in Minnesota and North Dakota. . . . *D. A. James Co., St. Louis, Mo., has been named distributor for General Electric Co., Silicone Products Dept., Waterford, N.Y. James will handle G.E. silicone products in Missouri and parts of Illinois.* . . . The St. Louis, Mo., sales office of Furane Plastics, Inc., Los Angeles, has been expanded to cover Iowa, Nebraska, Kansas, Oklahoma and Arkansas. Furane, a manufacturer of epoxy resin-based products, has also opened a new sales office in Palo Alto, Calif. That office will cover northern California. . . . *Investment Casting Co., Springfield, N.J., has appointed five new sales representatives: Anscott Engineering Co., Pittsford, N.Y.; Engineering Associates, Fort Worth; Thomas J. Fitzsimmons Co., St. Louis, Mo.; A. W. Risser, Grafton, Ohio; and Rohlfs & Craver Co., Cincinnati.* . . . L. G. White & Co., Silver Spring, Md., representative of Special Products Div., Melpar, Inc., Falls Church, Va., will cover an increased area. White will market Melpar tuning forks and frequency standards in the District of Columbia, Maryland, Delaware, New Jersey, North Carolina, South Carolina, and parts of Pennsylvania and Tennessee.

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contracts and procurements

AWARDS

AIR FORCE

$12,600,000—**Burroughs Corp.**, Detroit, Mich., for additional work toward production of 17 D825 data-processing systems providing emergency backup to the interceptor control program.

$4,000,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for manufacture of classified products for the ABRES (Advanced Ballistic Re-Entry Systems) Program.

$3,200,000—**Union Carbide Corp.**, New York City, for research and development on aerospace graphite (five contracts). Work to be done at the Advanced Materials Laboratory, Lawrenceburg, Tenn., and the Parma Research Laboratory, Parma, Ohio.

$2,100,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for advanced re-entry systems for space application.

$1,900,000—**Allied Shafer Co.**, South Gate, Calif., for construction of antenna facilities for a *Minuteman* ICBM site at Whiteman AFB, Mo.

$1,800,000—**Thiokol Chemical Corp.**, Brigham City, Utah, for research and development on solid propellant rocket motors.

$1,200,000—**Telemetrics, Inc.**, Gardena, Calif., for universal telemetry de-communication systems for use on the Atlantic Missile Range.

$1,000,000—**Alco Products, Inc.**, Chicago Heights, Ill., for heavy-duty springs and spring assemblies for *Minuteman* missile sites.

$757,000—**High Voltage Engineering Corp.**, Burlington, Mass., for a high-voltage particle accelerator.

$100,000—**Cubic Corp.**, San Diego, Calif., for the design of an all-weather vehicle-attitude measuring system.

$38,103—**Fairchild Stratos Corp., Space Systems Div.**, Rockville, Md., for re-entry nose cones.

Kollsman Instrument Corp., Elmhurst, N.Y., for development of a new gear-generating system and an in-process control capability (undisclosed amount).

General Dynamics/Astronautics, San Diego, Calif., for construction of five laboratories which will "hitchhike" into space aboard *Atlas* missiles and then go into orbit on their own power (undisclosed amount).

ARMY

$7,000,000—**Belock Instrument Corp.**, College Point, N.Y., for a radar station for guided missile systems.

$2,500,000—**Sperry Rand Corp., UNIVAC Div.**, Washington, D.C., for design and development of a computer and electronic input-output device for testing the experimental Multifunction Array Radar (MAR).

$2,000,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for work on the *Shillelagh* missile.

$1,400,000—**Western Electric Co.**, Whippany, N.J., for further development of the *Nike-Zeus* AICBM.

$377,978—**Graham Contracting, Inc.**, Orlando, Fla., for construction of a missile radar station on Merritt Island.

$339,000—**Lear Siegler, Inc.**, Santa Monica, for lightweight gyro azimuth surveying instruments.

NAVY

$1,700,000—**Northrop Corp.**, Anaheim, Calif., for engineering and logistics services on the *Polaris* missile system's checkout equipment.

$75,000—**Cubic Corp.**, San Diego, Calif., for introduction of major improvements in the COTAR (COrrelation Tracking and Ranging) tracking system at Point Mugu, Calif.

$56,700—**Rocket Power, Inc.**, Mesa, Ariz., for solid-propellant rocket motors.

NASA

$48,100,000—**Aerojet-General Corp.**, Azusa, Calif., for continued development and research toward an operational *SNAP-8* space power reactor system.

$1,300,000—**Farrell Construction Co.**, Memphis, Tenn., for dock facilities for handling propellants at Mississippi Test Operation of Marshall Space Flight Center.

$199,446—**Bell Aerosystems Co.**, Buffalo, N.Y., for development of miniaturized electrostatic accelerometers for evaluation of ion propulsion engines being developed for *Centaur*.

$188,000—**Robert & Co., Associated**, Atlanta, for design of a hangar for vehicle propellants.

$136,000—**Ortronix, Inc.**, Orlando, Fla., for a Digi-Comb solid-state system capable of detecting and conditioning weak telemetered signals from satellites.

$126,000—**Bechtel Corp.**, Vernon, Calif., for design of an addition to the components test facility at MSFC.

$56,646—**Goodyear Aerospace Corp.**, Akron, Ohio, for development, fabrication and testing of an insulation system to be installed on an experimental *Centaur* tank.

$46,755—**General Mills, Inc., Electronics Div.**, St. Paul, Minn., for a study of the sputtering effects on the Moon's surface.

$46,344—**Thompson Ramo Wooldridge, Inc.**, Cleveland, for additional funding on development of a dual-membrane fuel cell.

$30,175—**General Dynamics Corp.**, San Diego, Calif., for furnishing carbides to be used as cathodes in thermionic converters.

$29,450—**Avco Corp.**, Cincinnati, for satellite receivers.

$29,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for flow field prediction and analysis for Project Ram.

$25,070—**American Brake Shoe Co.**, Cambridge, Mass., for pressure transducers.

Gordon Enterprises, North Hollywood, Calif., for a pair of specially modified high-speed Mitchell 35mm cameras equipped with 48-in. Cyclotar lenses of unique design and construction to be installed on a special mobile tracking mount for missile and rocket test applications (undisclosed amount).

U.S. WEATHER BUREAU

$50,000—**Aerospace Corp.**, El Segundo, Calif., for a three-month cost analysis study of an operational meteorological satellite system.

INDUSTRY

$7,000,000—**Twin Industries Corp.**, Buffalo, N.Y., for unidentified work for **Boeing Co.** and **Grumman Aircraft Engineering Corp.**

$1,780,000—**Avco Corp., Aerospace Structures Div.**, Nashville, Tenn., from **United Technology Corp.**, for thrust termination tubes to be used aboard large solid-fuel rockets developed for the *Titan III* booster.

$400,000—**Quantic Industries, Inc., Pelmec Div.**, San Carlos, Calif., from **Avco Corp.**, for continuation of production of the *Minuteman* re-entry vehicle separation system.

$100,000—**DATEX Corp.**, Monrovia, Calif., from **Astro Structures Div. of Lear Siegler, Inc.**, for two complete precision angle encoding systems.

Informatics, Inc., Culver City, Calif., from **North American Aviation**, for consulting services in support of the computer-centered checkout systems for the *Saturn* Stage II booster. (undisclosed amount).

Hercules Powder Co., Wilmington, Del., from the **Boeing Co.**, for provision of the propulsion system for the experimental booster, *HIBEX* (undisclosed amount).

New Product of the Week:

Laser Metalworking System

A mobile laser metalworking system is being marketed by Maser Optics, Inc. The system is capable of welding or perforating spots as small as 1/1000 in.

The high-power laser beam will deliver energy equivalent to 10 million watts per sq. in. Power and firing rate are adjustable and the system can be operated manually or automatically. It features a viewing screen and its own power supply. The system employs a 3-in. ruby rod and xenon flash lamps.

Circle No. 225 on Subscriber Service Card

Serial Memory

Electronic Memories, Inc., is introducing a militarized, low volume serial memory. Designated SEM-2S, the device reads or writes at 200 kc and operates over a temperature range of −55° to 100°C. Bit sizes are available from 5,005 up to 150,150 bits, in 5,005-bit increments.

With all-welded subassemblies incorporated in welded modules, the device requires less than 45 cu. in. for a 1,010 bit memory.

Circle No. 226 on Subscriber Service Card

Wide-band Preamplifier

Halex, Inc., is marketing a Model 1020 thin-film wideband preamplifier with a constant gain of 51 db over a bandwidth of 100 kc, a constant input impedance of 10 K and a distortion figure of less than 1.5%.

The device has vacuum-deposited nichrome resistors and vacuum-deposited metal-film terminals and inter connections on a 0.75 x 0.75-in. encapsulated substrate.

Thickness of the module is 0.30 in. Power requirement is 6v ±10% nominal, 15 mw nominal. Frequency response is 10 to 100,000 cps. The device will operate over a temperature range of −55° to 100°C.

Circle No. 227 on Subscriber Service Card

Miniature Latching Relay

A series of minature, hermetically sealed latching relays is being produced by Electronic Specialty Co.

These 2PDT relays, Series 55R, are designed for resistive switching circuits in the dry-circuit energy level area. The relays can be placed in pre-wired boards or sockets in either of two positions without changing transfer characteristics or contact position. The units weigh 0.35 oz. and are approximately 1.8 x 0.4 x 0.4 in. Dry circuit contact rating is 10 amps resistive at 10mv dc or ac.

The relays have a rated minimum dry circuit life of 5 million operations at 10 cps and 125°C.

Circle No. 228 on Subscriber Service Card

Single Crystal Fluoride

Crystal Technology Dept. of Varian Assoc. has available a trivalent crystal matrix, LaF_3, as a host for rare-earth dopants for fundamental and applied laser-maser research.

LaF_3 is absorption free from 2,000 Å to 10 microns. It permits the direct substitution of the 3+ rare-earth ions into the lattice without charge compensation required for the divalent host lattices.

Single crystals ¼ in. in diameter are available up to 4 in. in length. Other rare-earth dopants in the LaF_3 matrix can be grown to specifications up to ½ in. in diameter.

Circle No. 229 on Subscriber Service Card

Solderless Terminals

ETC, Inc., is marketing solderless terminals and connectors mounted on plastic transparent tape belts to be automatically fed into crimping presses.

A mechanism positions terminal in crimping dies. Five tongue types and barrel styles in the 22 through 10 awg wire ranges are available.

Circle No. 230 on Subscriber Service Card

(Continued on p. 46)

PROJECT: F-111 and other Aerospace Programs

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missiles and rockets

SPECIAL REPORT: ADVANCED GUIDANCE AND CONTROL SYSTEMS FOR MISSILES & SPACECRAFT

issue: october 7, 1963 **advertising closing: september 30**

During the next few years designers and manufacturers of advanced guidance and control systems will play a major role in the military's future weapon systems and NASA's manned spaceflight programs.

On October 7, MISSILES AND ROCKETS, The Weekly of Space Systems Engineering, will present a complete report covering advanced guidance and control systems. This special Report will include:

1—Total Market Survey

- **Expenditure Estimates Through 1975**
- **Major Research & Development Trends**
- **Rundown of Major Companies in The Field**

2—Survey of Advanced Guidance & Control Systems

- **Aerospace Plane**
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- **Lance**
- **Mauler**
- **Minuteman**
- **MMRBM**
- **Polaris A-3**
- **Saint**
- **Shrike**
- **Slam**
- **Sidewinder-C**
- **Titan III**
- **Typhon**

3—Advanced NASA Systems

- **Rendezvous Techniques**
- **Gemini**
- **Apollo**
- **Lunar Excursion Module**
- **Lunar Logistics Supply**
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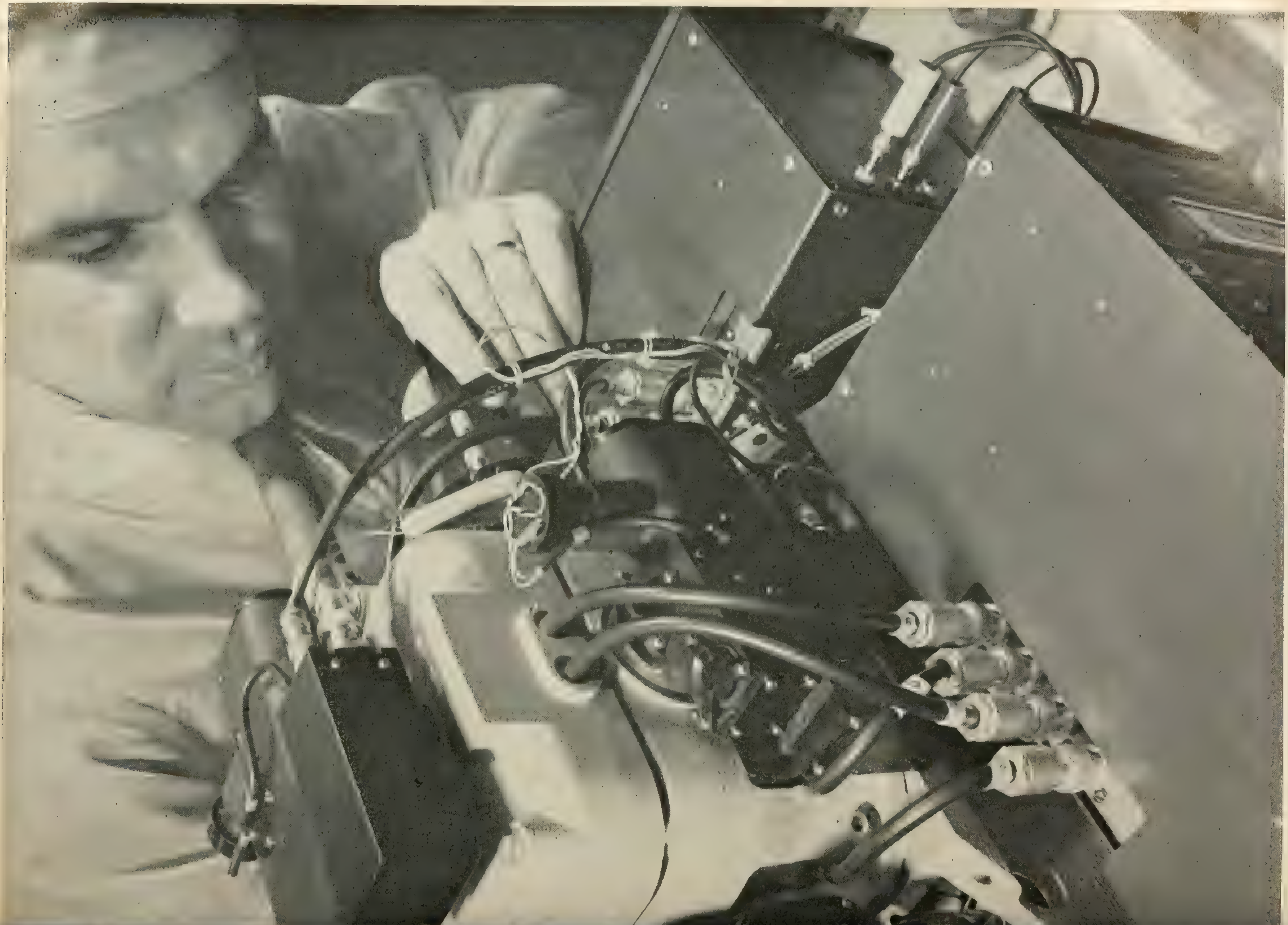

VLF Phase Comparison

Develco, Inc., has available a VLF receiver and phase comparator system. The Model 3004A is fixed-turned, optionally to 16, 18, 20 or 60-kc frequency standard transmissions.

The phase comparator provides an output voltage bearing a linear relationship to the phase difference between a signal derived from the monitored frequency standard and from the National Bureau of Standards-referenced VLF frequency standard transmission. This may be connected to a recording device for a record of frequency correlation.

An amplitude output provides a logarithmic measure of incident field strength, thus monitoring the VLF transmission.

The device receives, simultaneously, any two desired VLF frequency standard transmissions. An antenna with response tailored to the two frequencies provides input for two channels of circuitry, each essentially identical to the single channel Model 3004A. Separate phase and amplitude outputs are provided for each channel.

Circle No. 231 on Subscriber Service Card

Screwdriver-Set Switch

Unimax Switch, a division of Maxson Electronics Corp., has developed a subminiature single-pole, double-throw switch, for use where accidental or unauthorized opening or closing of an electric circuit must be avoided. The Type ISL3-1 operates with a 90-degree turn of a screwdriver-slotted shaft. A positive detent maintains the desired contact setting.

The device has a ¼-in. diameter bushing for mounting on panels up to $\frac{3}{32}$-in. thick. A keying tab on the mounting bracket provides positive orientation.

The basic switch equipped with this actuator is the Unimax Type USM5 single-pole-double-throw switch which meets MIL-S-6743 and Military Drawing MS-25085-1. Electrical rating: 5a. 125-250v ac; 5a 30 v dc. resistive; 3a 30v dc, inductive.

Circle No. 232 on Subscriber Service Card

Tungsten Carbide Coatings

Metco, Inc., has developed a tungsten carbide alloy, Metco XP1139. The powder is self-fusing and self-bonding to steel and many other materials. It contains 12% cobalt aggregate, which is applied with a plasma flame spray process, using nitrogen as the primary gas.

Thickness of XP 1139 coatings can be varied from 0.002 to 0.015 in. With removal of less than 0.005 in. of material, coatings can be ground and lapped to finished of 2 to 4 microinches, AA or better.

For short exposures, coatings will tolerate temperatures considerably above their 1,900°F softening point in many atmospheres.

Circle No. 233 on Subscriber Service Card

Foamed Metals

A process for the manufacture of foamed metals, applicable to a great variety of metals including tungsten and molybdenum, has been developed by Ipsen Industries, Inc.

These sintered foams have a cellular structure with interconnecting pores which permit rapid outgassing in a vacuum. Densities may be secured in any range from 12% of theoretical.

The resulting products of foaming may be readily sawed or machined. Slight grinding of the sawed surface causes smearing of the metal and closing of the surface pores. Metal foams are easily brazed to solid metal in a vacuum furnace and a strong composite is thereby obtained.

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For complete information on solid or flexible carbon and graphite, call National Carbon.

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Laser Research Dewar

Sulfrian Cryogenics has developed a liquid helium research dewar to be used with masers operating in the microwave and optical spectra. The device is also applicable as a catalyst in chemical reactions, a transmitter in an optical radar system, a monochromatic source for optical measurements and as a source for optical communication systems.

The liquid helium in the inner container of the dewar brings temperatures down to 4.2°K. A crystal is inserted into the liquid helium through an inlet tube. The light source is separated from the test crystal by a glass window that preserves the vacuum in the chamber.

Circle No. 235 on Subscriber Service Card

Krytron Firing Unit

A firing unit for exploring bridgewires using a Krytron tube in place of a spark gap has been developed by Edgerton, Germeshausen & Grier, Inc.

The unit, with only 28-v dc input, discharges 2,000 amps in 1.5 microsec. directly into an EBW load. The device uses a Krytron, cold cathode tube as its trigger discharge switch, requires a trigger voltage of less than 1 kv, and has a dynamic operating range of 3:1. It can be encapsulated for high altitude use.

Circle No. 236 on Subscriber Service Card

Sub-Miniature Phase Shifter

A sub-miniature phase shifter, providing a 180-degree phase shift with RG-58 cable in C Band has been announced by Applied Engineering Products Co.

Attachment cables of the device do not rotate and distance between cables is changed by a maximum of ¼ in. VSWR ratio is less than 1.3:1 through the band. The unit is 2¾ in long and can be adapted to any type and size cable. It meets all applicable military specifications.

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Electric Power Divider

A power divider for coaxial cables is available from Cannon Electric Co. The aluminum device provides an equal power division through each arm at 240 megacycles. The mating ends are type "N" female and will mate with any type "N" 50-ohm plug.

The VSWR is less than 1.5:1 at 240 megacycles, and the maximum insertion loss is 0.5 db. The power division at both output arms has a 50-ohm impedance.

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BOEING OPENINGS ON SATURN S-1C

Boeing has primary developmental, building and test responsibility for NASA's S-1C Saturn V first-stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

This rapidly expanding program provides unique advancement advantages and ground-floor opportunities to physicists, mathematicians and engineers with the following specialties: electrical/electronics, propulsion, structural design, systems test, manufacturing, tooling, facilities, aerodynamics, cryogenics and high vacuum technology.

Salaries are commensurate with all levels of education and experience. Minimum requirement is a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly hired personnel.

Saturn assignments are in New Orleans as well as in Huntsville, Alabama. Other missile and space programs at Boeing's Aero-Space Division include the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle.

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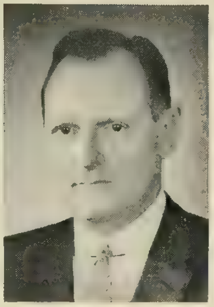
DURAND

MC BREEN

Stirling E. Babcock: Appointed director of advance program development for the Hydro-Aire Div. of Crane Co., Burbank, Calif.

Dr. Ronald (Roy) Smelt: Appointed vice president and chief scientist for Lockheed Aircraft Corp., Burbank.

Paul L. Schiavone: Appointed controller of the eastern operation of Sylvania Electronic Systems Div. of Sylvania Electric Products, Inc., Waltham, Mass.

Donald J. Loundy: Named new product development engineer for the Mica Corp., Culver City, Calif.

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Jackson W. Granholm: Elected vice president of Informatics, Inc., Culver City, Calif.

John Donald Durand: Joined the Aerospace Industries Association as assistant director of industry planning service for procurement and finance, Washington, D.C.

Dr. Gordon Ferrie Hull, Jr.: Appointed director of research in the Research and Engineering Dept. of Baird-Atomic, Inc., Cambridge, Mass.

Wesley L. McBreen: Appointed quality control manager at Halex, Inc., El Segundo, Calif.

James J. Croke: Named head of Mitre Corp.'s Intelligence Systems Dept., Bedford, Mass.

Robert H. Hollister: Appointed director of military marketing of Motorola Overseas Corp., Chicago.

Charles V. Gerdes: Appointed assistant manager, government agency sales, at Electronic Communications, Inc., St. Petersburg, Fla.

Donald V. Caldwell: Named contracts manager of the Bendix Products Aerospace Div. of the Bendix Corp., New York City.

Joseph S. Imirie: Former Assistant Secretary of the Air Force (Materiel) will join Litton Industries, Beverly Hills, Calif., as corporate vice president for the Industrial Group, effective Oct. 1.

Dr. Max T. Weiss: Named associate general manager of the Laboratories Div. at Aerospace Corp., El Segundo, Calif.

Dr. William M. Mueller: Named manager of manufacturing of the microwave tube division of Hughes Aircraft Co., Culver City, Calif. **Bruce A. Highstrete** named manager of research and development.

Dr. Bernhard H. Goethert: Director of Engineering for ARO, Inc., at the USAF's Arnold Engineering Development Center has been named to NASA's Research Advisory Committee on Fluid Mechanics.

F. A. Stephenson: Appointed chief engineer for propulsion systems at General Dynamics/Astronautics, San Diego, Calif.

Dr. Domenic Bitondo: Appointed technical director of the Bendix Corp.'s Systems Div., Ann Arbor, Mich.

Robert L. Tibbs: Named marketing manager for space electronics at Avco Corp.'s Electronics Div., Cincinnati.

J. W. Hinchliffe, Jr.: Appointed corporate director of materiel for Northrop Corp., Beverly Hills, Calif.

William G. Tuscany: Appointed manager of product planning for Erie Resistor Corp., Erie, Pa.

George A. Garrison: Named general purchasing agent for the Norton Co., Worcester, Mass.

William Duncan: Appointed Washington, D.C., district manager of the Atomic Defense and Space Group of Westinghouse Electric Corp.

Morris E. Johnson: Appointed defense industry representative for United States Steel Corp., Pittsburgh.

William J. Hutts: Named plant superintendent for the Precision Metal Product Div. of Fairchild Camera and Instrumen Corp., El Cajon, Calif.

Clifford W. Kropp: Appointed sales engineer at Vitro Electronics division o Vitro Corp. of America, Silver Spring, Md

Robert A. Stone: Named manager o Air Reduction Sales Co.'s operations planning department, New York City.

John W. Coolidge: Elected president o Applied Engineering Products Co. divisio of Atronics Corp., Stamford, Conn.

Oral D. Koch: Appointed general manager of Mallory Electronics Co., Indianapolis.

Jerome Herman: Appointed sales manager for Computer Instruments Corp.' Medical Electronics Div., Hempstead, N.Y

Robert Zwart: Appointed supervisor o the project engineering department o Haveg Corp., Wilmington, Del.

when and where

SEPTEMBER

Aeroelastic and Dynamic Modeling Technology Symposium, sponsored by AF Systems Command's Aeronautical Systems Div. and the AIA, Biltmore-Hilton Hotel, Dayton, Ohio, Sept. 23-25.

International Telemetering Conference, Hilton Hotel, London, Sept. 23-27.

Second Annual Symposium on the Physics of Failure in Electronics, sponsored by the Rome Air Development Center and Armour Research Foundation, Chicago, Sept. 25-26.

XIVth International Astronautical Congress, International Astronautical Federation, Paris, Sept. 26-Oct. 1.

IRE Canadian Electronics Conference, Toronto, Sept. 30-Oct. 1.

AIAA Meeting on Engineering Problems of Manned Interplanetary Exploration, Cabana Motor Hotel, Palo Alto, Calif., Sept. 30-Oct. 1.

OCTOBER

Eighth National Symposium on Space Electronics, Institute of Electrical and Electronics Engineers, Fontainebleau Hotel, Miami Beach, Oct. 1-3.

AIEE Fall General Meeting, Pick-Congress Hotel, Chicago, Oct. 6-11.

IRE National Communications Symposium, Hotel Utica, Utica, N.Y., Oct. 7-9.

Corrosion of Military Equipment Committee, National Association of Corrosion Engineers, Admiral Semmes Hotel, Mobile, Ala., Oct. 8-9.

21st Annual Aerospace Electrical/Electronics Conference, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Oct. 9-11.

Materials Handling Conference, sponsored by ASME, AIEE and IRE, Chamberlain Hotel, Newport News, Va., Oct. 14-15.

Course on Space Power Systems, sponsored by George Washington University's College of General Studies, Airlie Center, Warrenton, Va., Oct. 14-25.

Users of Automatic Information Display Equipment Annual Meeting, Carillon Hotel, Miami Beach, Oct. 15-17.

Eighth Symposium on Ballistic Missile and Space Technology, sponsored by AF Space Systems Div., AF Ballistic Systems Div., and Aerospace Corp., Naval Training Center, San Diego, Calif., Oct. 15-18.

AIAA/CASI, RAeS Ninth Anglo-American Conference, Massachusetts Institute of Technology, Cambridge, Oct. 16-18.

American Vacuum Society, National Symposium on Vacuum Technology, Statler-Hilton Hotel, Boston, Mass., Oct. 16-18.

Tenth East Coast Conference on Aerospace and Navigational Electronics, Emerson Hotel, Baltimore, Oct. 21-23.

American Society for Metals, Annual Meeting and National Metals/Materials Show and Exposition, Public Auditorium, Cleveland, Oct. 21-25.

Ninth Conference on the Design of Experiments in Army Research, Development and Testing, Redstone Arsenal, Huntsville, Ala., Oct. 23-25 (by invitation only).

Human Factors Society, Annual Meeting, Ricky's Hyatt House, Palo Alto, Calif., Oct. 23-25.

Optical Society of America Annual Meeting, Sherman House, Chicago, Oct. 23-25.

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Memo from the Publisher

I HAVE taken over this page from the editor this week because I want to report to you on some of the events which have taken place since the appearance of the article and editorial in MISSILES AND ROCKETS concerning the threat to our missile deterrent posed by possible Soviet anti-ballistic missile (ABM) developments.

The achievement of the MISSILES AND ROCKETS editorial staff in bringing before the U.S. Senate one of the most critical aspects of the proposed nuclear test ban treaty must be recorded as an outstanding journalistic accomplishment. It also should be stated that it has provided a significant service to the nation.

I have been asked how the story was obtained. I am not at liberty to discuss our sources on the story. I can say that it was not, as the London *Daily Telegraph* has suggested, a deliberate leak by Air Force opponents of the test ban treaty.

The resources of the entire MISSILES AND ROCKETS editorial staff were marshalled to develop in a very short time the information which supported and appeared in the article which you read last week. Because of the significance of the material to the debate then proceeding in the Senate, the presses were held for three hours in order to get the story into print as soon as possible.

Of equal importance to the story itself, I believe, is the decision to publish it. I want to remind you of what editor Bill Coughlin said here last week:

"We are aware that the subject discussed in the article and on this page is one of the highest national security classification. There is no justification for such a security classification. The Soviets have carried out tests on the electromagnetic pulse phenomena of high-yield weapons and know that we have not. They also are acquainted with the possibilities of its ultimate application . . ."

I want to point out that there is sound basis for the belief that the Administration was employing security for political purposes in regard to the treaty.

Gen. Curtis LeMay was asked before the Senate Preparedness Subcommittee whether he would recommend that the treaty be signed if it were being considered in the proposal stage, rather than after signing. The Air Force Chief of Staff answered that he did not think he would recommend signing. Obviously, no security is involved in that answer.

Yet Sen. John Stennis (D-Miss.) told the Senate: "The original statement made by Gen. LeMay was not permitted to be cleared in our transcript. It was marked classified and was not allowed to be cleared. But we later learned that the statement had appeared in the press, so on my own responsibility I cleared the statement."

Sen. Strom Thurmond (D-S.C.) told the Senate: "It is also true that some time after he testified, a written proposed modification of Gen. LeMay's answer was submitted to the Preparedness Subcommittee . . . If accepted, an evasive answer would have appeared in the printed record of the hearings. The Preparedness Subcommittee rejected the proposed change.

"For the information of those who do not yet know, if any there are, I point out that the Dept. of Defense reviews carefully all the transcripts of hearings," the Senator continued. "The screening is done by Dept. of Defense censors. They screen not only for security—and in this instance they were not screening for security, for that is a process now in progress—but also for compliance with the policy of the Administration."

I think the statements of those two Democratic Senators make it quite clear that the Administration was using security for political purposes.

MISSILES AND ROCKETS brought into the open the possibility that the Soviets might be developing the capability to neutralize U.S. missiles in their silos for just one reason—not to take a stand for or against the treaty but to permit this critical issue to be fully considered by the Senate.

I am pleased to report that purpose was achieved. By the beginning of this past week, one press association had called it the most highly debated issue of the test ban discussion.

On Friday, Sept. 13—the day on which the Sept. 16 issue reached Washington subscribers—Sen. Milward Simpson (R-Wyo.) placed the M/R article and parts of the editorial in the Congressional Record during the debate on the Senate floor.

On Monday, Sept. 16, Sen. Thurmond asked Sen. John Sparkman (D-Ala.) during the debate about Soviet ABM capabilities: "Has the Senator seen the issue of MISSILES AND ROCKETS?"

Sen. Sparkman replied: "I have not yet seen that issue."

Sen. Thurmond stated: "This magazine contains an article and an editorial on this very question. I hold the editorial in my hand. It reads in part as follows . . ."

Sen. Thurmond then read from the editorial, expanded on the subject and told the Senate: "That is no phony objection raised to the treaty. It is a direct reality. It is a reality that has been pointed out by the magazine MISSILES AND ROCKETS, an engineering magazine whose editors feel that the treaty is an extremely dangerous instrument . . ."

IN THIS, Sen. Thurmond went further than we had gone and we were pleased to have Sen. Hubert Humphrey restore our objectivity. The Minnesota Democrat told Sen. Thurmond:

"Let us see what the editorial says. The editorial is not nearly as conclusive and definitive as is the Senator from South Carolina. It reads, in part:

'The possibility of Soviet development of such an ABM system based on high-yield testing that the United States has not matched is not in itself a reason for rejection of the treaty.'

"Perhaps I ought to repeat that."

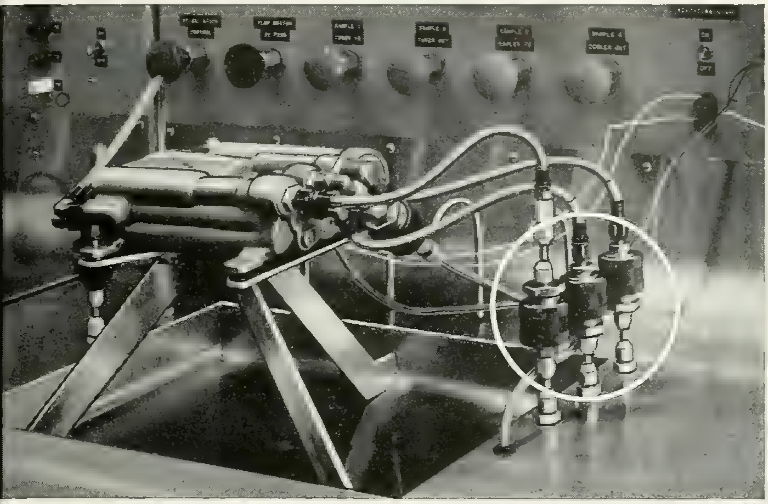
Sen. Sparkman interjected: "I think it bears repeating. People should remember that statement."

The debate on the Senate floor, and the wide play given to the article on the news and editorial pages of papers both in the U.S. and abroad, provide a dramatic demonstration of the editorial impact of this magazine, stemming both from editorial enterprise and editorial responsibility.

I think the MISSILES AND ROCKETS reporters and editors lived up to both last week in the best traditions of the journalistic profession.

James W. Claar
Publisher

POSITIVE TEMPERATURE CONTROL FROM 100W TO 55KW



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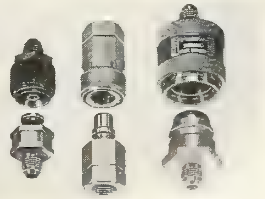

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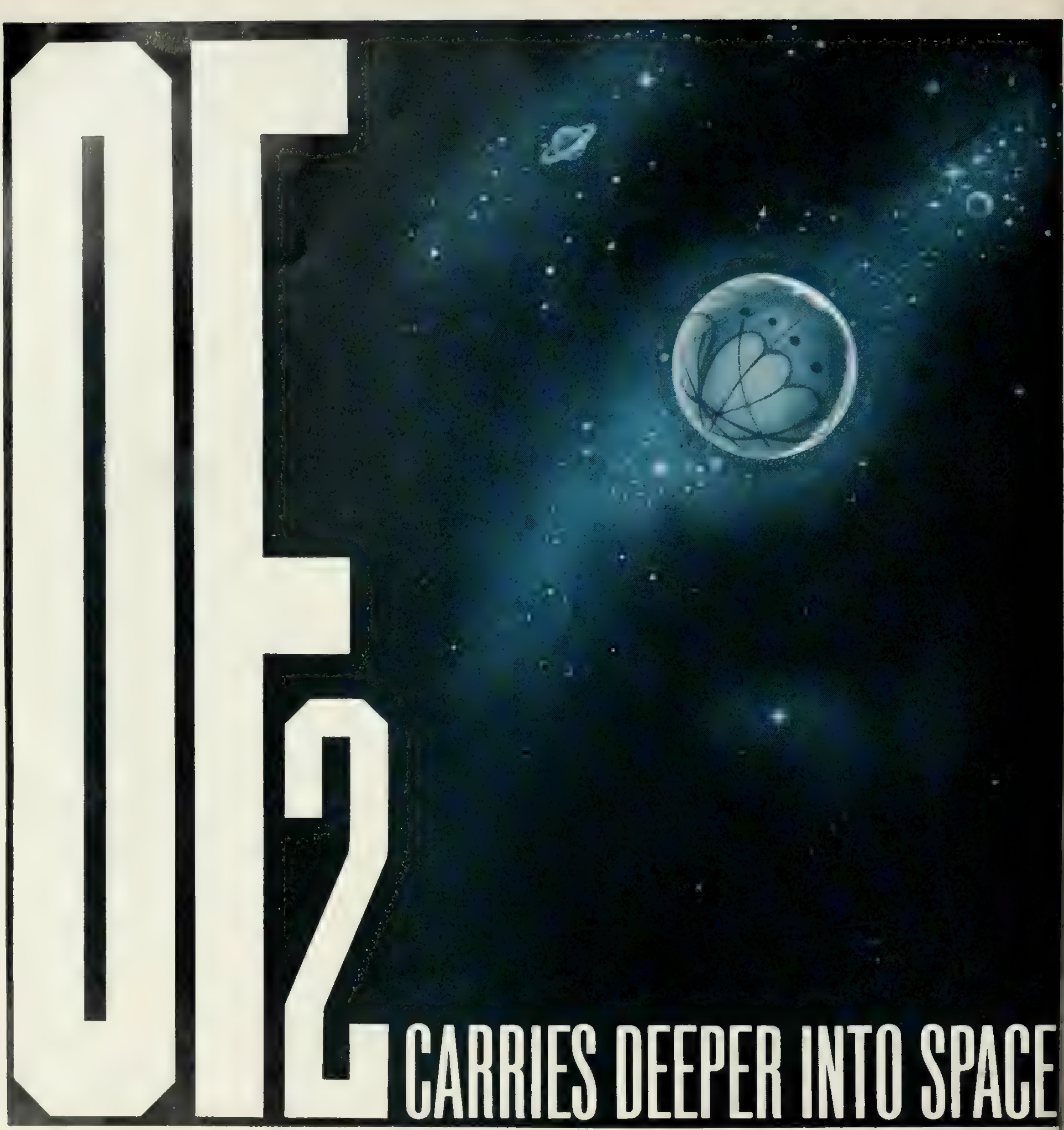

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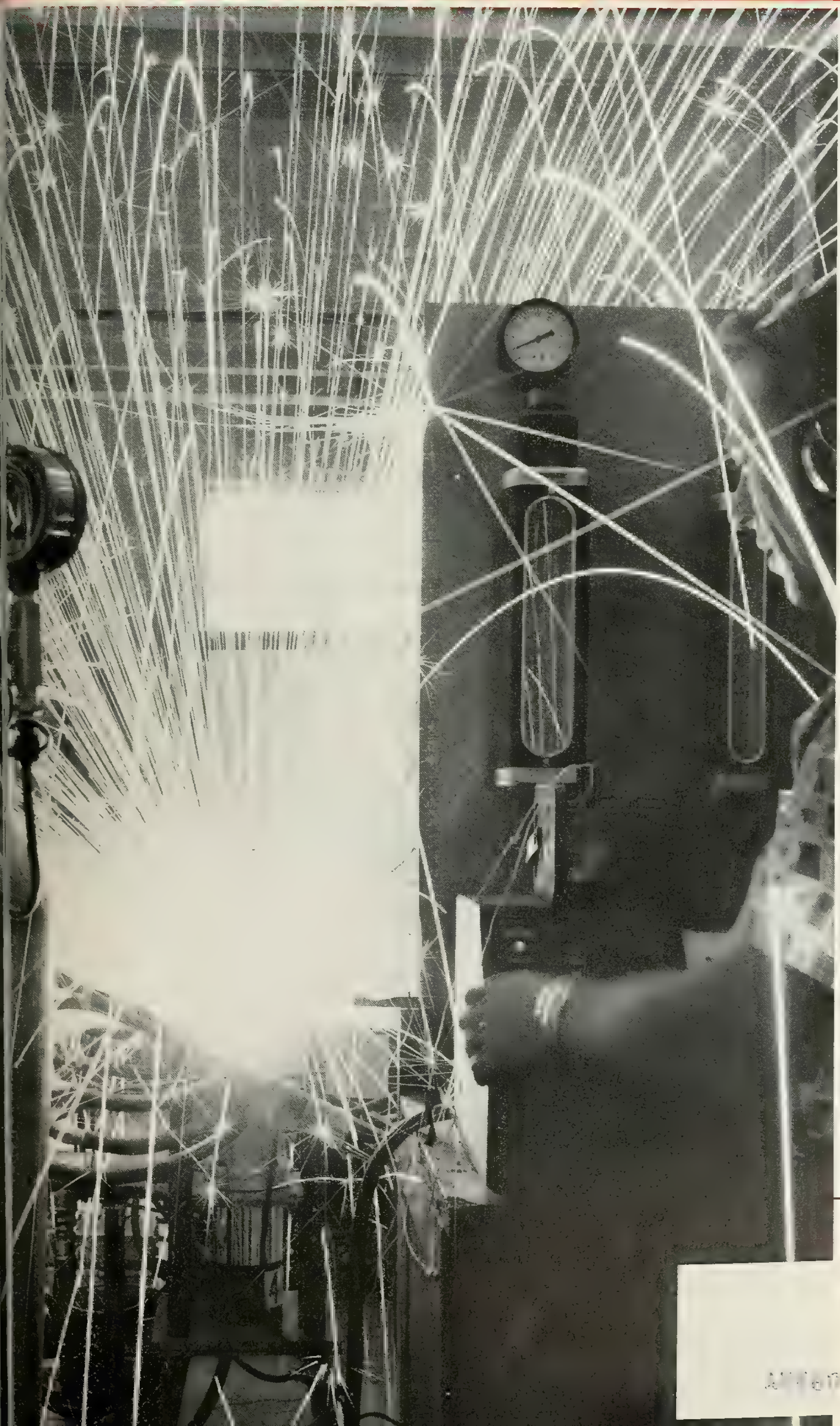

Scientists Call for Release of EMP Data

Effects of JFK's Proposal

Theodolite for Saturn Guidance

Progress at Mississippi Site

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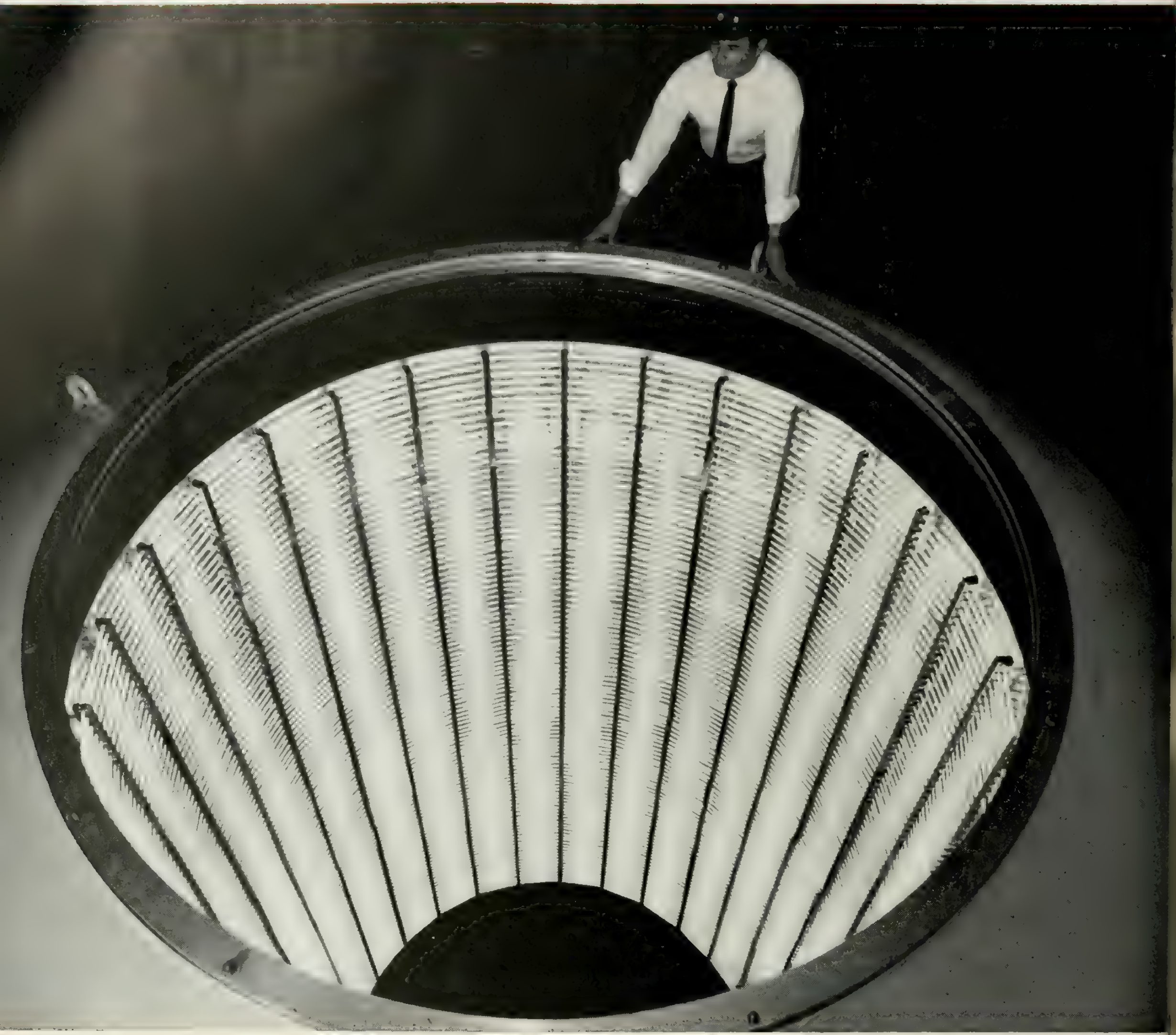

This is where Beech puts the heat on major space age problems

Nation's largest transient heat laboratory is a vital part of a comprehensive systems management capability

Inside this six-story building, temperature ranges from −423°F. to +1,500°F. may be achieved. 3,000 quartz lamps, programmed and operated from a remote control center, can simulate elements of standby and boost phases of flight.

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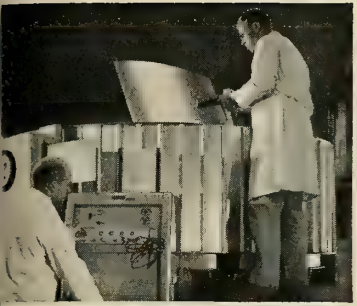

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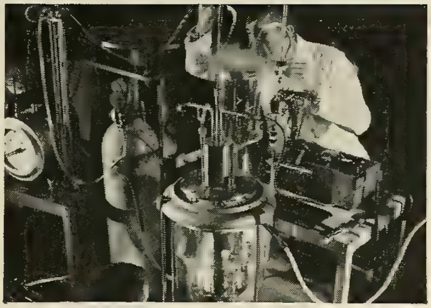

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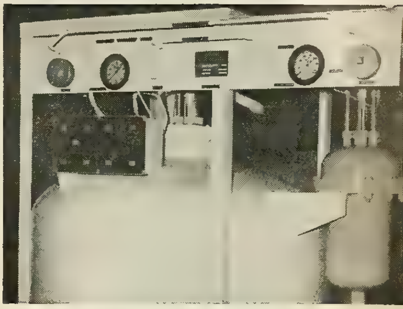

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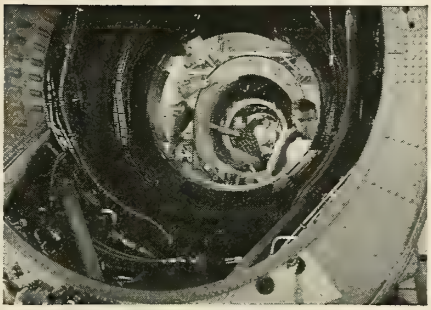

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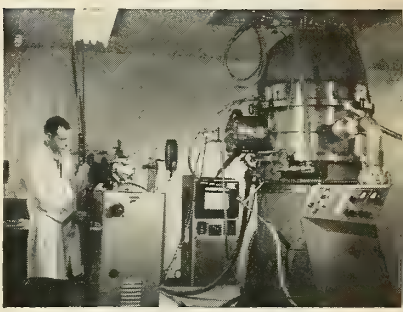

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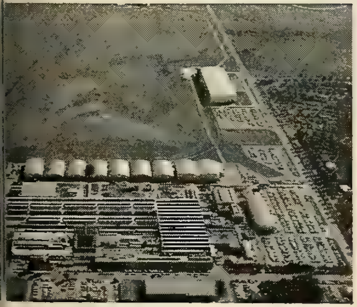

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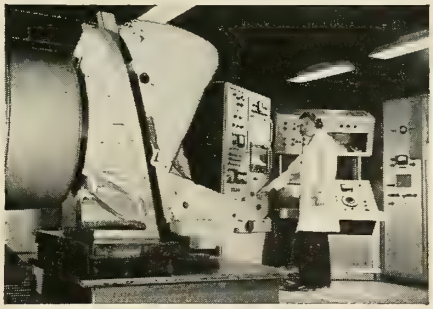

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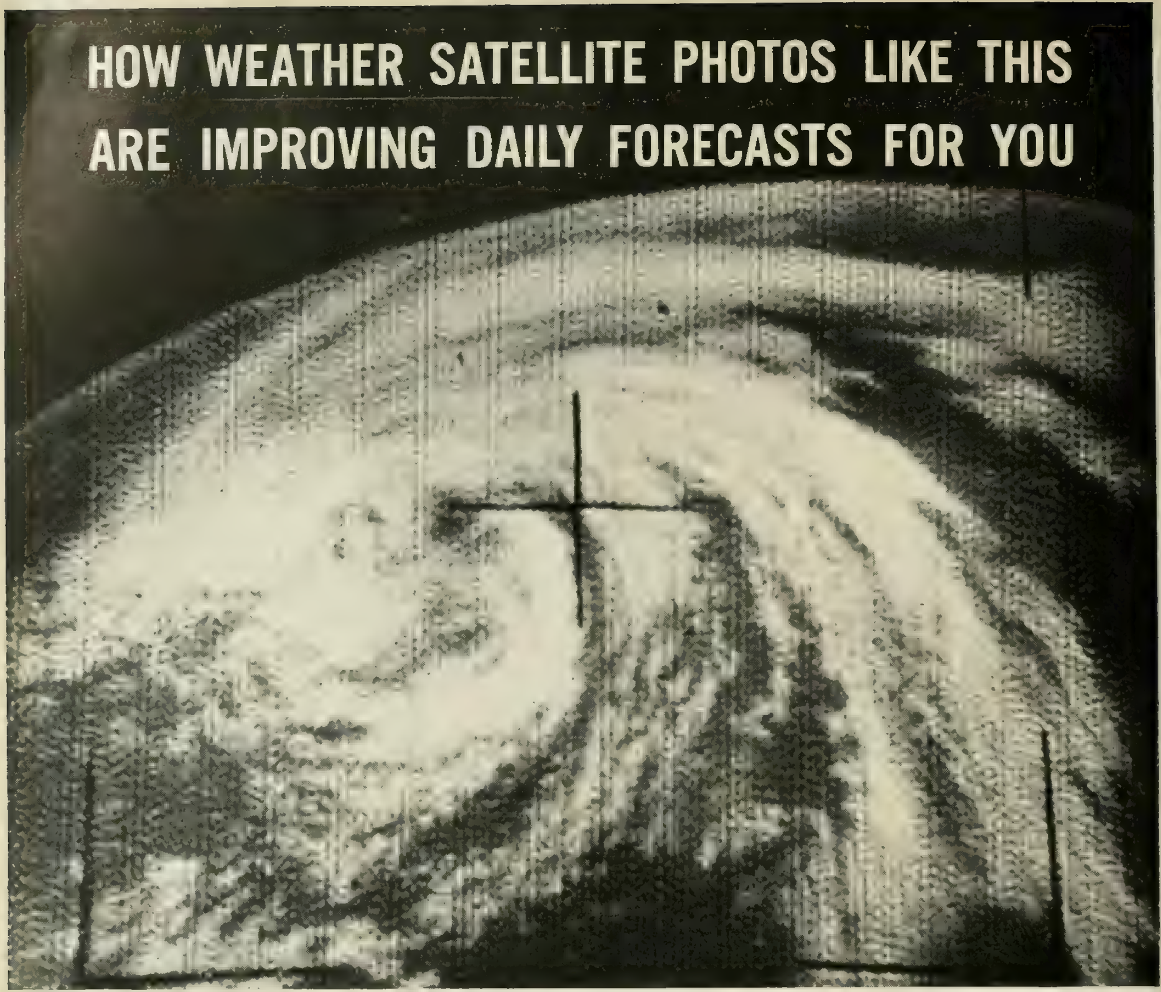

TIROS SATELLITE PHOTOGRAPH of a typhoon in the Pacific Ocean shows huge pinwheeling system of white clouds. Photo was taken from a height of 450 miles; cross in center and angles at corners are reference points.

Military defense agencies count on swift Bell System communications to receive weather information from space and around the world

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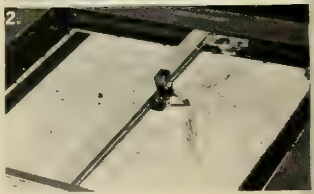

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 14 September 30, 1963

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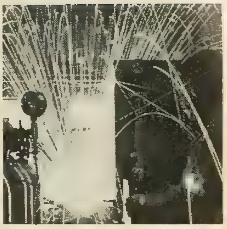

Droplets of rapidly melting zirconium explode upon oxidation in tests that are part of a program probing effects of re-entry speeds and air densities in reducing material to tiny particles. Materials melting tests are being conducted at Cornell Aeronautical Lab.

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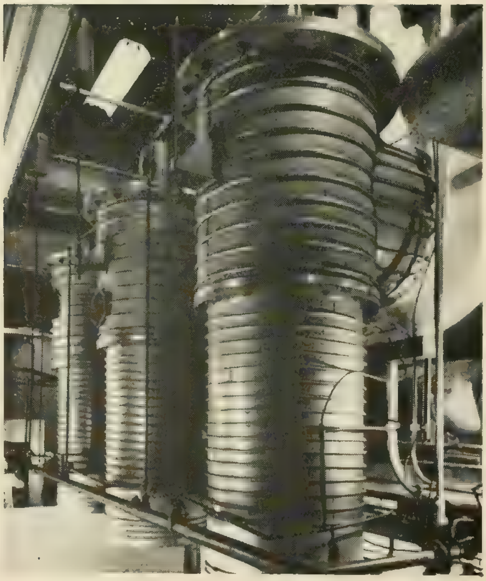

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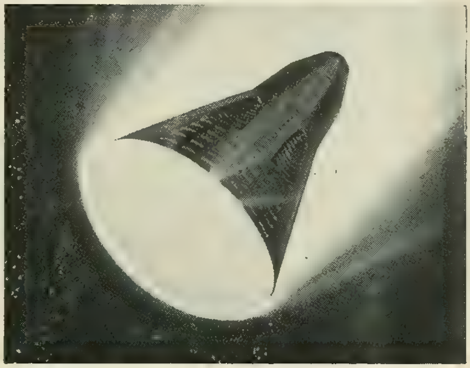

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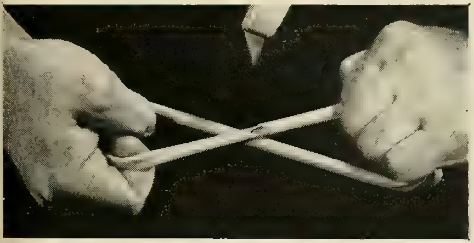

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Soviet ABM Capability

To the Editor:

Either your "intelligence sources" or your reporter, or both, erred in your Sept. 16 issue when reporting that the Soviets may have ultimate ABM capability. In today's rapidly advancing technology it is difficult if not impossible to define just what an ultimate weapon of any specific type would be. Certainly it would have to be inherently invulnerable to negation or degradation by *any* means, known or unknown, regardless of any possible or even inconceivable advances in the state of any pertinent art, or any alternative courses of action that might be taken by the intended victim.

By your own statements and Dr. Teller's testimony before the Senate, the Soviet ABM capability doesn't even come close to this capability when *Polaris* missiles are considered. Moreover, your article, and the Editorial in the same issue, completely ignore the subject of countermeasures. Even granting that very-high-energy nuclear bursts could radiate sufficient electromagnetic energy to disable our present missiles in their silos (which has not yet been proven to the engineering population at large), such a result would be meaningless without considering the effects of electromagnetic shielding which could and would be installed to protect against such a threat.

The threat posed by a successful (not necessarily ultimate) ABM capability cannot be properly assessed in any event without considering all possible courses of action. Expanding and perfecting the *Polaris* system as suggested by Dr. Teller is an example of one possible course of action. Changing our strategic posture from a "second strike" to a "concurrent strike" capability is another alternative. Silo and missile shielding must definitely be investigated.

By all means, let's bring these matters out in the open if they are going to affect our decision on whether or not to sign the test-ban treaty. But let's not succumb to one-sided news reporting or sensationalism to produce a bias in our assessment of the political, military, economic, and survival implications of such an important matter.

R. A. Wall
Sunnyvale, Calif.

To the Editor:

The article on Russian ABM work ontains a serious error which may lead to rroneous conclusions on the part of your eaders. The statement made that Nevada ests are restricted to yields of 20 kilotons r less is *not* true.

The AEC announces tests at the Ne'ada Test Site as having yields in either he low or intermediate range. Low yields re defined as 20 kilotons or less; internediate yields are in the range between 20 ilotons and one megaton. Only two weeks go a test in the intermediate yield range vas conducted at NTS.

As far back as 1951 nuclear detonations in Nevada have exceeded 20 kilotons. Between 1951 and 1958 alone at least 16 tests with yields greater than 20 kilotons occurred. On July 6, 1962, one of the more highly publicized nuclear detonations at NTS occurred. This was the Sedan shot of Project Plowshare which weighed in at 100 kilotons.

In view of the fact that you consider this article to be one of the most important published in your magazine since its founding, it would seem to be to your advantage to check before making a statement which can be so easily disproved.

Edward C. Walterscheid
Livermore, Calif.

To the Editor:

Re: Possible Russian ultimate ABM electromagnetic pulse bomb. Can electromagnetic waves of any strength or frequency penetrate great depths of water, earth, and shielding? Are you not talking about the secondary effects of primary particles—that is, neutrons which can penetrate to great depths? In other words, are you not describing the oft-discussed hydrogen-neutron bomb with its high percentage of tremendous energy in the form of deeply penetrating neutrons? Such neutrons would cause emission of EMF pulses each time they disintegrate a partcile. They could not only damage electronic gear but could make duds out of fission bomb triggers. Such a bomb, if developed, could possibly do what you attribute to the EMP bomb. Discovery of such a bomb by Russia could explain their sudden desire for a test ban while they develop and deploy it.

T. M. Morse
Planning Engneer, Vandenberg AFB
Santa Maria, Calif.

Sounding Rockets Abroad

To the Editor:

Your editorial, "Supermarket for Space" (M/R, Aug. 26, p. 60), based on the interview with Rep. Joseph E. Karth (D-Minn.) appearing in the same issue, forms a sound and clear placing of the problem of promoting space research in the Free World countries.

Such thoughts and policy on the part of officials, as well as reports of public opinion in the United States, are really very encouraging, and their realization will have good repercussions not only in U.S. industry but also on the promotion, to a large scale, of space research.

But, to your sound views regarding the selling by the U.S. of space boosters to other Free World countries, let me add the matter of sounding rockets, for any kind of probes and meteorological research, for which there is still ample scope for the scientists. Due importance should also be given to the disposal of rockets of this category to other countries, from the viewpoint not only of the widening of business for American industry, but also of the promotion to routine status of sounding rocket measurements.

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However, this is prevented by the still-high price at which such rockets are disposed of. A little while ago, an opportunity was given to us to discuss extensively in Athens on this subject with a spokesman of one of the best-known manufacturers of sounding rockets.

For most of the European countries the price of $1,500-2,000 per launching is rather forbidding. That is why efforts are already beging made in many countries, so that each develop its own type of rockets, on a local industries contribution basis.

I am sure that if due attention is given, there will be found a solution so that small American solid-propellant rockets may be sold at considerably lower prices. This will undoubtedly result in benefiting not only the development of such research and measurements in many countries, but also American industry itself, on account of the most considerable increase of orders.

All of us have been expecting from U.S. manufacturers a display of initiative.

Apostolos Ch. Frangos, B.A.
Scientific Rockets Research
Group on Space
Athens, Greece

Lunar Casualties

To the Editor:

From time to time you have published articles pertaining to our national lunar exploration program. Recently you wrote that the U.S. had failed five times in its attempt to explore the Moon.

This is true of the *Ranger* program only and neglects previous disasters.

This letter is written to set the record straight. As you can see from the following list, we made a total of 14 attempts to gather lunar data. Unfortunately, none of these tries was successful, but hopefully we'll make it this autumn!

The record (date, launch vehicle, purpose & results):

Aug. 17, 1958—*Thor-Able*—Lunar probe; first-stage engine failure after 77 sec. of flight caused explosion in midair.

Oct. 11, 1958—*Thor-Able*—Lunar probe; reached maximum altitude of 70,700 mi.

Nov. 8, 1958—*Thor-Able*—Lunar probe; third stage did not burn, reached maximum altitude of 963 mi.

Dec. 6, 1958—*Juno II* (*Pioneer III*)—Lunar probe (intended near-miss); reached maximum altitude of 63,680 mi.

March 3, 1959—*Juno II* (*Pioneer IV* —Lunar probe; missed Moon by 37,300 mi., orbiting Sun. Did not get close enough to obtain lunar data.

September, 1959—*Atlas-Able I*—Luna probe; blew up on pad.

Nov. 26, 1959—*Atlas-Able II*—Luna probe; exploded after 45 sec. of flight.

Sept. 25, 1960—*Atlas-Able III*—Luna probe; insufficient velocity, vehicle destroyed on re-entry.

Dec. 15, 1960—*Atlas-Able IV*—Luna probe; exploded at 40,000 ft.

Aug. 23, 1961—*Atlas-Agena B* (*Range I*)—Lunar vicinity (intended miss) reached maximum altitude of 120 mi.

Nov. 18, 1961—*Atlas-Agena B* (*Range II*)—Same as *Ranger I*, above.

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Jan. 26, 1962—*Atlas-Agena B* (*Ranger III*)—Lunar impact; missed Moon by 23,000 mi.; no TV pix; lost attitude stabilization; in solar orbit.

April 23, 1962—*Atlas-Agena B* (*Ranger IV*)—Lunar impact; spacecraft malfunction caused vehicle to tumble—no data obtained; missed Moon's leading edge by 900 mi.; turned and impacted on invisible side.

Oct. 18, 1962—*Atlas-Agena B* (*Ranger V*)—Lunar impact and close-up TV pictures; lost attitude stabilization because of electrical failure; missed Moon and entered heliocentric orbit.

H. Alfred Roloff
Melbourne, Fla.

Over-50 Opening

To the Editor:

Reference is made to a Letter to the Editor in your Sept. 9 issue entitled "Personnel Runaround."

I am interested in securing qualified and mature engineering personnel in either mechanical or electronic options; therefore, the gentleman's age of 50 does not bother me in the slightest. I believe, as do many, that a career for well-rounded engineers in the service of the U.S Government can be extremely challenging, diversified and rewarding; not, as so many believe, a home for the inept. Should the gentleman whose wife wrote the letter in question be within the engineering categories mentioned above, and if he is interested in employment within government, I would be very much interested in hearing from him and seeing his qualifications.

C. P. Jones
Technical Director
Explosive Ordnance
Disposal Facility
U.S. Naval Propellant Plant
Indian Head, Md.

Encyclopedia Reprints

Reprints of Missiles and Rockets' *Seventh Annual World Missile/Space Encyclopedia, which appeared in the July 29, 1963, issue, are now available. They may be ordered from:*

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99 SUCCESS STORIES

LOX AND LN$_2$ STORAGE (–297 TO –320° F)

NO.	COMPANY	CAPACITY*	LOCATION
1	AIR PRODUCTS	131 MG OF LN$_2$	CHICAGO, ILL.
2	AIR PRODUCTS	82 MG OF LOX	CHICAGO, ILL.
3	AIR PRODUCTS	78 MG OF LOX	CLEVELAND, O.
2	AIR PRODUCTS	52 MG OF LOX	PITTSBURGH, PA.
1	AIR PRODUCTS	52 MG OF LOX	WIERTON, W. VA.
1	AIR PRODUCTS	62 MG OF LOX	SPARROWS PT., MD.
2	AIR PRODUCTS	178 MG OF LN$_2$	SPARROWS PT., MD.
3	AIR PRODUCTS	100 MG OF LOX	SANTA SUSANA, CALIF.
1	AIR PRODUCTS	200 MG OF LOX	SANTA SUSANA, CALIF.
1	AIR REDUCTION	54 MG OF LN$_2$	CITY OF INDUSTRY, CALIF.
1	AIR REDUCTION	54 MG OF LN$_2$	S. ACTON, MASS.
1	AIR REDUCTION	270 MG OF LN$_2$	RICHMOND, CALIF.
1	AIR REDUCTION	108 MG OF LN$_2$	BEAUMONT, TEX.
1	AIR REDUCTION	43 MG OF LOX	BEAUMONT, TEX.
1	AIR REDUCTION	350 MG OF LOX	BUTLER, PA.
1	AIR REDUCTION	350 MG OF LOX	CLAYMONT, DEL.
1	AIR REDUCTION	330 MG OF LN$_2$	BUTLER, PA.
1	AIR REDUCTION	330 MG OF LN$_2$	CLAYMONT, DEL.
1	AIR REDUCTION	330 MG OF LN$_2$	ACTON, MASS.
1	AIR REDUCTION	50 MG OF O$_2$	CHICAGO, ILL.
1	AIR REDUCTION	50 MG OF O$_2$	CITY OF INDUSTRY, CALIF.
2	AIR REDUCTION	350 MG OF LOX	ALBION, MICH.
1	AIR REDUCTION	300 MG OF LN$_2$	WARREN, OHIO
1	AIR REDUCTION	300 MG OF LOX	WARREN, OHIO
1	DRAVO	110 MG OF LOX	FARRELL, PA.
1	DRAVO	35 MG OF LN$_2$	FARRELL, PA.
1	FORD MOTOR CO.	115 MG OF LOX	DETROIT, MICH.
2	LINDE	217 MG OF LOX	HUNTSVILLE, ALA.
1	LINDE	700 MG OF LOX	HUNTSVILLE, ALA.
1	LINDE	700 MG OF LOX	ASHTABULA, O.
1	LINDE	217 MG OF LOX	PUEBLO, COLO.
2	LINDE	217 MG OF LOX	NEOSHO, MO.
1	LINDE	217 MG OF LOX	EAST CHICAGO, IND.
1	LINDE	131 MG OF LOX	LACKAWANNA, N.Y.
1	LINDE	87 MG OF LOX	YOUNGSTOWN, O.
2	LINDE	87 MG OF LOX	ECORSE, MICH.
1	LINDE	217 MG OF LOX	ESSINGTON, PA.
1	LINDE	87 MG OF LOX	DEER PARK, TEX.
2	LINDE	217 MG OF LN$_2$/LOX	PITTSBURG, CALIF.
1	LINDE OF CANADA	131 MG OF LOX	SAULT STE. MARIE, ONT.
1	N.A.S.A.	125 MG OF LOX	CAPE CANAVERAL, FLA.
1	N.A.S.A.	56 MG OF LN$_2$	CLEVELAND, O.
1	N.A.S.A.	35 MG OF LN$_2$	CAPE CANAVERAL, FLA.
1	N.A.S.A.	64 MG OF LN$_2$	GREENBELT, MD.
3	N.A.S.A.	75 MG OF LOX	NIMBUS, CALIF.
2	N.C.G.	35 MG OF LOX	CHICAGO, ILL.
1	ROCKETDYNE	100 MG OF LOX	SANTA SUSANA, CALIF.
3	ROCKETDYNE	220 MG OF LOX	EDWARDS AFB, CALIF.
1	ROCKETDYNE	300 MG OF LN$_2$	EDWARDS AFB, CALIF.

LH$_2$ STORAGE (–423° F)

AIR PRODUCTS	200 MG	LONG BEACH, CALIF.
AIR PRODUCTS	200 MG	LONG BEACH, CALIF.
AIR PRODUCTS	90 MG	INDIANA TOWN, FLA.
AIR REDUCTION	100 MG	PEDRICKTOWN, N. J.
DOUGLAS AIRCRAFT	90 MG	NIMBUS, CALIF.
DOUGLAS AIRCRAFT	90 MG	NIMBUS, CALIF.
LINDE	342 MG	ONTARIO, CALIF.
LINDE	44 MG	TORRANCE, CALIF.
LINDE	750 MG	SACRAMENTO, CALIF.
N.A.S.A.	100 MG	NIMBUS, CALIF.
N.A.S.A.	100 MG	NIMBUS, CALIF.
N.A.S.A.	227 MG	MERCURY, NEV.
N.A.S.A.	110 MG	MERCURY, NEV.
N.A.S.A.	105 MG	NIMBUS, CALIF.
N.A.S.A.	70 MG	MERCURY, NEV.
N.A.S.A.	250 MG	NIMBUS, CALIF.
N.A.S.A.	250 MG	NIMBUS, CALIF.
PRATT & WHITNEY	90 MG	UNITED, FLA.
ROCKETDYNE	560 MG	SANTA SUSANA, CALIF.
ROCKETDYNE	90 MG	SANTA SUSANA, CALIF.

LNG SHIPMENT AND STORAGE (–259° F)

CONSTOCK, TANKER— "METHANE PIONEER"	32,000 BBL LNG	OCEAN TANKER
CONCH, TANKER	170,000 BBL LNG	OCEAN TANKER
METHANE TANKER LTD.	170,000 BBL LNG	OCEAN TANKER
CONSTOCK LIQUID METHANE	35,000 BBL LNG	LAKE CHARLES, LA.
NORTH THAMES GAS BOARD	16,400 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	16,400 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
C. A. duMETHANE LIQUIDE	69,189 BBL LNG	PORT ARZEW, ALGERIA
C. A. duMETHANE LIQUIDE	69,189 BBL LNG	PORT ARZEW, ALGERIA

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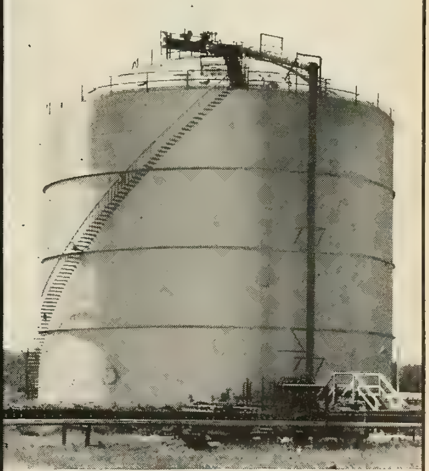

Flat-bottom tanks used for storage of liquid nitrogen, oxygen and methane.

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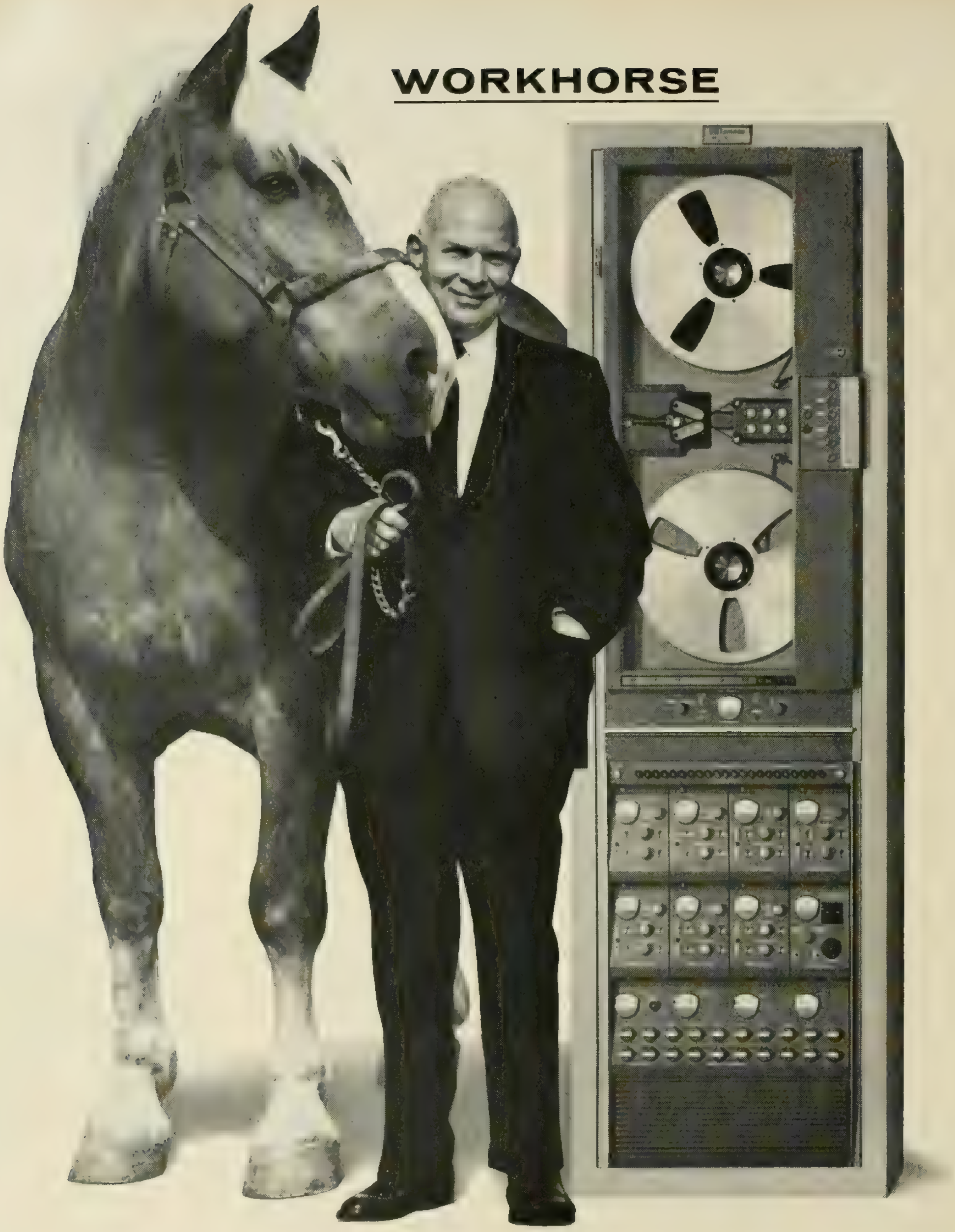

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The Countdown

WASHINGTON

NASA Adopting New Contract Method

Announcement by NASA of a new cost-plus-fixed-fee/incentive type contact is imminent. It will be used first on the *Lunar Orbiter Photo* spacecraft, which is replacing the *Surveyor* orbiter. Besides the possibility that it will hike profits, a major advantage for industry is that the new system probably will keep unqualified firms from bidding on contracts—primarily because of fines for poor performance.

AF Moves to Speed MOSS Planning

Air Force R&D has set up a new post of deputy director of development for space, to help mesh its manned orbital space station planning studies with those of NASA. Acting director is Col. Kenneth W. Schultz. Office will give staff support to AF Undersecretary Brockway McMillan as well as Maj. Gen. Andrew J. Kinney, director of development planning.

Space Batting Average Climbs

Reliability in the U.S. space program is increasing rapidly. In 1959 the average time before the first malfunction showed up in an unmanned spacecraft was 10 days. In 1962 this jumped to two months. During the same period, average useful lifetime of a satellite has increased from about 15 days to six months. In 1962, NASA also chalked up an 82% mark for successful launches.

Negotiated Contracting Hangs On

Congress is asking Defense Secretary McNamara why there has been no increase in competitive bidding on defense contracts, in spite of McNamara's contention that 25% of costs can be saved by dropping negotiated contracts. Little action has followed this statement, some senators say.

Three Lunar Rovers Slated

The lunar rover payload for the *Surveyor* spacecraft has been all but officially approved by NASA. Flights will follow immediately after the first seven lunar soft-lander spacecraft, and at least three flights will be scheduled. Payload will weigh about 100 lbs. Two concepts are being studied: one controlled by radio command from Earth, the other by guidance within the *Surveyor.*

Dividing Lunar Landing Pie

Launch vehicle equipment will account for $7 billion of the estimated $20-billion pricetag for the manned lunar landing program. Other items: $6 billion for *Gemini* and *Apollo* spacecraft; $7 billion for support. About $1.5 billion of the latter figure covers the completed *Mercury* project, the *Ranger* and *Surveyor* programs, and the *Orbiting Solar Observatory.*

Navy Ponders Missile R&D Reshuffle

Shifts in responsibility between the Bureau of Weapons and the Bureau of Ships could result from a current Navy study of where to divide up development tasks for shipboard missile systems. Division has been roughly between missiles and their fire-control/guidance systems on the one hand and acquisition radar, computing and handling elements on the other. Changes could realign contacts between bureaus and suppliers.

Dyna-Soar Stock Rises

Recent Air Force contract awards are reviving hopes for *Dyna-Soar* expansion. There's now some expectation in industry circles that the mission role may be widened to capitalize on the winged spacecraft reconnaissance and penetration possibilities. AFSC's Space Systems Division now has acquired full test responsibility for *X-20,* including drop and orbital tests. Aeronautical Systems Division retains R&D responsibility.

INDUSTRY

Honeywell Eyes Bigger Systems Jobs

Honeywell's Explosive Ordnance Division is expanding to develop a greater systems capability. A new 99,000-sq.-ft. R&D facility will be constructed adjoining the division's present headquarters in Minneapolis. EOD plans to compete in the area of larger systems for both NASA and DOD, including such areas as battlefield reconnaissance.

S-IV On Scene at Cape

An S-IV second stage for the *Saturn 1* booster has arrived at Cape Canaveral after a flight from the Douglas Aircraft Co. plant in Sacramento. The liquid hydrogen stage will be launched aboard the *SA-5* vehicle in November or December.

Renegotiation Knives Honed

The Renegotiation Board is expecting a boom year in 1964, as it begins handling space contracts. Whereas 390 cases appeared before the group in FY 1962, and 550 in FY 1963, there will be more than 600 in FY 1964. The Board has recovered more than $2 billion from industry since its inception 11 years ago.

INTERNATIONAL

SS-11's On Order Pending TOW

U.S. Army authorities have decided to adopt the Hughes *TOW* antitank missile and have dropped the idea of manufacturing the French-designed *SS-11* under license in the U.S. Douglas Aircraft and Nord Aviation had proposed to turn out the weapons in this country. However, Nord will receive an order for 20,000 *SS-11's* to be built in France while the development of *TOW* is accelerated.

Japanese To Form Space Science Group

Japan's Defense Agency plans to establish a space science development organization this year to direct development of rockets, satellites and boosters. The Agency also hopes to gain further U.S. cooperation in R&D for Earth satellites and rockets. It plans to send survey missions to the U.S. and to hold conferences and discussion meetings with its space science counterparts in this country.

The Missile/Space Week

Apollo G&N Due Soon

The first flight-type *Apollo* guidance and navigation (G&N) system is expected to be completed by the first of the year, according to official spokesman for the program.

At a press conference held last week at the Massachusetts Institute of Technology, NASA officials, MIT scientists, and industry engineers involved in the $200 to $300-million program to develop the highly flexible system reported that the supporting hardware development program is on schedule and that beating the original timetable is a distinct possibility.

The G&N system, including its three major subsystems—high speed computer, inertial measurement unit and optical system—will be packaged in a 4-ft.-high, 2-ft.-deep, 3-ft.-wide volume within the command module. Under peak power operation, the system will require several hundred watts power, according to MIT. In standby mode, it will require under 100 watts.

As a system, the *Apollo* G&N will be able to operate completely independent of ground inputs, but will have capability for ground data input if required. It will also serve as backup to launch vehicle guidance in the event of a *Saturn V* guidance failure during boost. Actual mission for the G&N will begin once the translunar trajectory has been entered. Current plans call for the *Saturn* S-IVB stage guidance system, enclosed in the *Saturn* instrument unit, to handle the injection into the translunar trajectory. The *Apollo* system could also fulfill that role, if needed.

(MISSILES AND ROCKETS *will include complete description of* Apollo *guidance next week in its Special Report on Advanced Guidance and Control Systems.*)

Boeing Studies 'Moon Talk'

Communications on the Moon is one of the major problems being studied by Boeing Aerospace Div. engineers under a NASA lunar base investigation contract.

Prime obstacle to overcome is that the line of sight to the Moon horizon from ground point-to-ground point is only about three nautical miles.

Solutions being studied include a multi-purpose antenna tower, rising several hundred ft. above the surface and cable connection between Moon ground points.

Boeing also feels that there may be requirements for commercial quality television at a lunar site. Portable TV cameras carried by astronauts on scientific expeditions could be important aids to lunar exploration. As a result, the firm will also study the requirements for transmission of television and film data, picture resolution and frame rates.

French Space Funds Cut

France has reduced its 1964 civilian space budget from $70 million to $48 million.

The reduction is part of that nation's economic austerity program, Gen. Aubiniere, President of CNES, the organization managing the civilian space program, told a meeting of the French Aerospace Writers Association in Paris recently.

The $20 million marked for the international ESRO/ELDO programs will also be reduced by 20 per cent, but this money may be replaced if France—as expected—modifies those treaties shortly.

Funds for research by government, university and industry laboratories will also be cut to $8.6 million. Other cuts will affect the short-range satellite programs, reduced from four to two, and the four tracking stations that are scheduled to be constructed.

The reductions will not affect the more spectacular parts of the French space effort, the launching of *FR-1* and *FR-2*. *FR-1* will be launched from the U.S. Pacific Missile Range using a *Scout* booster. Meanwhile, research contracts have been concluded with French companies for the equipment of *FR-2*, to be launched early in 1965 by a *Diamant* launcher from the Hammaguir range, near Colomb-Bechar, Algeria.

There was no reduction in CNES' $10 million contribution for development of *Diamants*.

Shots of the Week

Army troops conducted three successful firings of the *Pershing* ballistic missile from near Blanding, Utah, to an impact point in the White Sands Missile Range, N.M., Sept. 24 and 25. Firings were conducted by A Battery, 2nd Missile Battalion, 44th Artillery, from Ft. Sill, Okla., under what the Army termed "near tactical conditions."

Other shots of the week:

- A joint NASA-Japanese research shot using an *Aerobee 150 A* rocket was successfully fired from the space agency's Wallops Island, Va., launch site Sept. 25. The 185-lb. Japanese instrument payload was lofted to 139 miles altitude, and landed some 80 miles out in the Atlantic.
- An Air Force Strategic Air Command crew from Forbes AFB, Kans., successfully fired an *Atlas* ICBM from Vandenberg AFB, Calif., Sept. 25. Launch was a routine training mission.
- Army artillery troops launched a *Redstone* tactical missile at White Sands Missile Range, N.M., Sept. 23. Shot was the 12th consecutive success for the 10-year-old missile.
- A *Titan II* ICBM was launched by an Air Force crew from a silo at Vandenberg AFB, Calif., Sept. 23 in what was described as a research and development test. The 103-ft.-long missile carried a dummy nuclear warhead toward a target area more than 6700 miles out in the Pacific.

SSGS Competition Begins

The Air Force has begun seeking bids for development of its Standardized Space Guidance System (SSGS), which could eventually provide guidance and control for all future spacecraft, regardless of mission or orbital trajectory (M/R, Sept. 9, p. 16).

Space Systems Division of the AF Systems Command on Sept. 24 briefed prospective bidders on the program definition phase of the ambitious system.

Thompson Ramo Wooldridge (Space Technology Laboratories), General Precision, Inc. (Aerospace Systems Div.) and Univac Division of Sperry Rand Corp. formed the first announced team to seek SSGS awards.

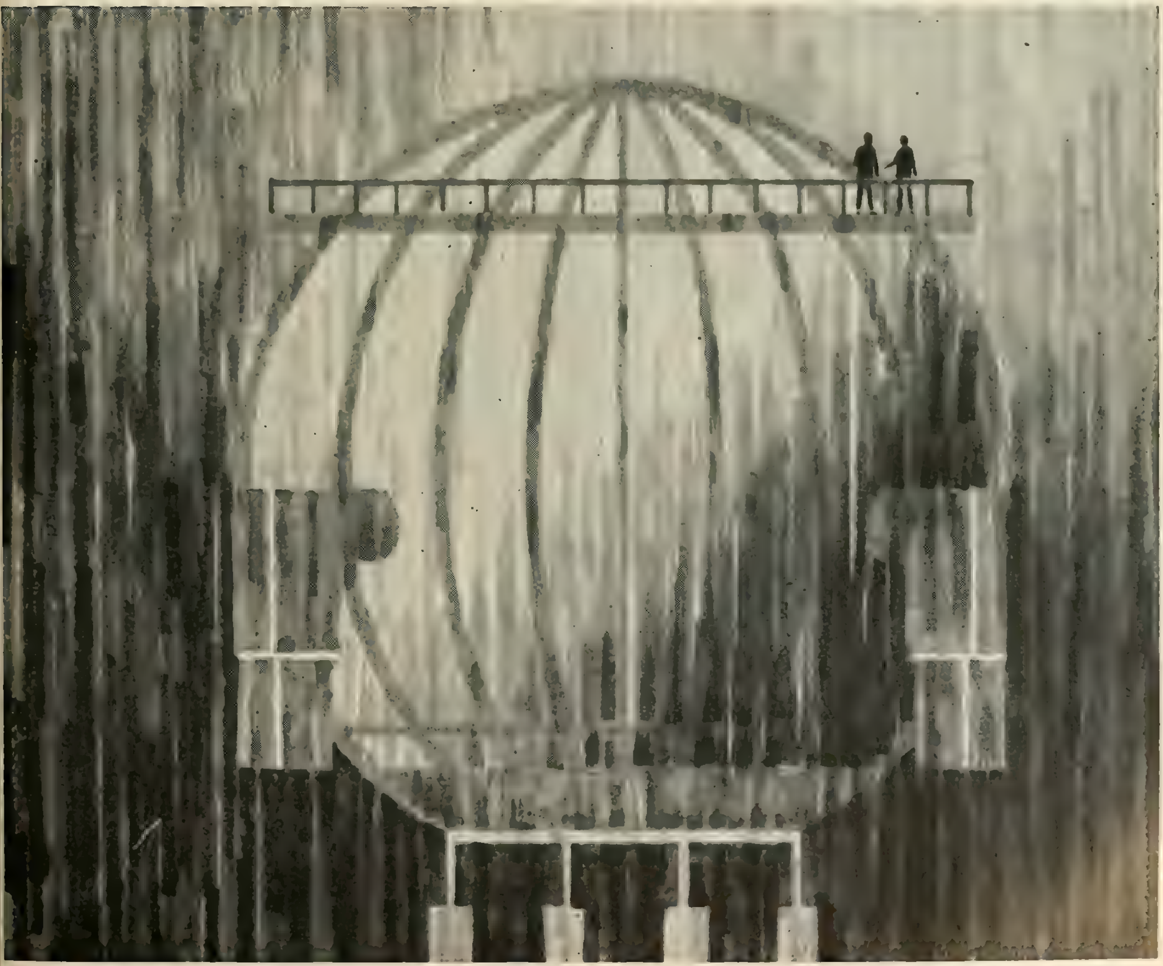
TRW, which has designated Arthur V. Sommer as SSGS program manager, would be prime systems contractor. Univac would provide computer subsystem support. GPI would supply navigational equipment and sensors.

There were reports that another team composed of AC Spark, IBM and Kearfott might enter the competition. Honeywell was said to be

What will man's problems be in the vast emptiness of outer space? How will the materials and systems he will use stand up? Will his communications with earth work properly? □ At the new Douglas Space Systems Center in Huntington Beach, California, many of the required answers will be found. Part of the Center is an environmental laboratory where space "hardware" up to 30 feet wide can be tested at vacuum levels and temperatures which would be encountered 500 miles out. Other units can produce deeper space conditions down to a vacuum of 10^{-14} torr and with any required radiation and gravity situations. □ Such research facilities are basic for the development of manned and unmanned satellite systems, launching and space vehicles, earth to moon communication devices, lunar housing and vehicles, life support systems, and similar projects in which Douglas is involved.

FAR OUT FACT FINDING

...AND WHAT DOUGLAS IS DOING ABOUT IT



Other research programs covering some 23 broad technological areas are under way in the major Douglas divisions located at Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

DOUGLAS

considering a team entry.

The competition is expected to lead first to four study contracts worth from $300,000 to $350,000 each. These would be followed by two program definition contracts of about $10 million each. Size of the final contract award will be dependent on the space programs then in view.

Rainmaking Art Advances

Weather modification techniques have been unexpectedly advanced by results of experiments with colored smoke charges to mark high-altitude rocket warhead bursts.

The new technique resulted from attempts of chemists at the Naval Ordnance Test Station, China Lake, Calif., to find cohesive and easily visible smoke-spotting charges. Iodine compounds were experimented with because of their reddish-purple color. When lead iodate was used to produce an iodide cloud, weather modification possibilities became apparent.

The seeding devices used are solid-propellant gas generators in which silver iodate (a substitute for lead iodate) is used as one of the oxidizers with a high-energy binder. During combustion, it is reduced to silver iodide vapor.

The method is considered superior to both the ground-based acetone burners used in earlier U.S. weather control experiments and the iodide-loaded flare compositions which have been air-dropped in experiments by the Russians.

Senate May See NASA Pacts

Sen. Margaret Chase Smith (R-Me.) has called for the submission of the full text of NASA's international agreements to the Senate Space Committee.

Sen. Smith made the request to Sen. Clinton Anderson (D-N.M.) because "some of these agreements are not unlike treaties."

She also proposed that the agency supply information on amendments and the extent of these commitments.

"It is incumbent upon our committee to have full knowledge of the nature and extent of these commitments," Sen. Smith said. As an example she cited the recent space agency agreement to cooperate with the Soviet Academy of Sciences.

Marines May Get Boost

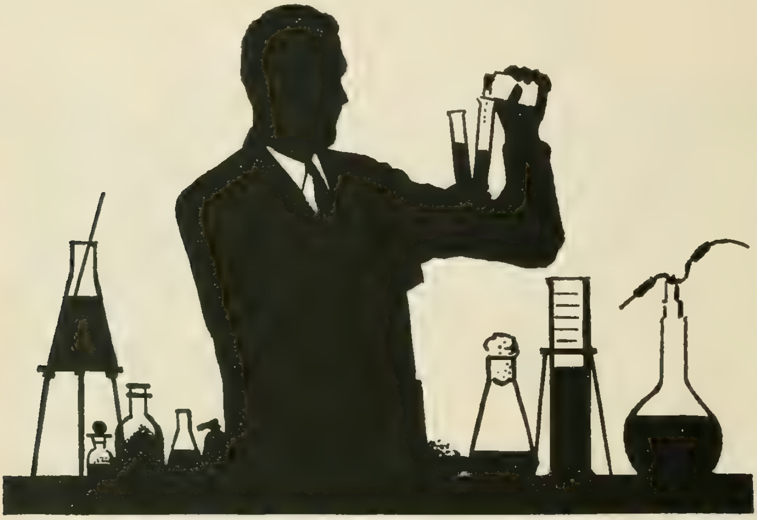
Lt. Gen. Wallace M. Greene, who will succeed Gen. David M. Shoup at the end of the year as commandant of the Marine Corps, foresees the possibility of future Marines being transported into brush fire combat areas via rockets.

Admitting that the idea was still "on the horizon," he said that a king-size *Dyna-Soar*-type vehicle, carried aloft by a *Saturn*-type rocket, might conceivably be used to transport as many as 1,200 Marines.

Not yet entirely resolved is the problem of landing or otherwise deploying the leathernecks from the craft.

Reinforced Plastics Course Set

A short course on the principles and applications of reinforced plastics, with emphasis on missile/space, will be given at UCLA from October 21 through Nov. 1. The fee is $250.00 and applications may be obtained from Dept. K, University Extension, University of California, Los Angeles, 24, Calif. George Epstein of ARA, Inc. will be the instructor, with guest lecturers from major missile/space manufacturers interested in reinforced plastics. Dr. H. F. Mark, director, Polymer Research Institute, Polytechnic Institute of Brooklyn, will be a special guest lecturer.



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Motion study. Induced rotation of a Manned Orbital Research Laboratory under study by NASA, which would provide artificial gravity for its crew, could also introduce unwelcome twist, tumble, spin and wobble in space. □ Because these motions can best be arrested by precision stabilization, Sperry is under contract to NASA Langley Research Center (1) to make dynamic analyses of the types of motion which may be encountered; (2) to derive control laws which may be applied to the resultant problems; (3) to generate control concepts which will guarantee station stability. □ Because orbital times up to a year are under study, a manned station presents a unique challenge in control. Sperry experience in gyroscopics, aerospace control, undersea stabilization logically suits us for the task. General Offices: Great Neck, New York.

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By two U. S. scientists . . .

Release of EMP Data Urged

Goldwater enters joint paper in Congressional record during test ban treaty debate; weapon systems 'hardening' advocated

by Heather M. David

TWO U.S. SCIENTISTS have called for a change in military specifications for missile systems and a hardening of existing strategic and tactical weapons to protect them against the electromagnetic effects of nuclear explosions (M/R, Sept. 16, p. 14; Sept. 23, p. 19).

Dr. John A. Kuypers of Stanford University and Dr. V. W. Vodicka, technical director of Joslyn Electronic Systems Division, called for a release of classified information on the electromagnetic pulse (EMP) effects on weapons, command and communication systems. Dr. Kuypers told MISSILES AND ROCKETS that some scientists have recognized the problem since the early nuclear tests were made, but security clamps were put upon these data.

Sen. Barry Goldwater (R-Ariz.) presented the views of the scientists when he entered the draft of a still-unpublished paper written by them in the Congressional Record during the nuclear test-ban treaty debate.

The scientists said most of the significant data are available only through unclassified technical journals from the USSR, France and Britain, and from those U.S. scientists who are not silenced by government security. They added that there is no handbook which can be used by systems designers as an information source.

The authors charged that "the present Mil-Spec series is completely inadequate to meet the total reliability requirements of communications and weapons systems facilities." It does not recognize the real integrated EMP problem, they said. When some of the effects are recognized, but systems solution is not readily apparent, "the problem is classified and withheld from personnel who must have the information in order to design systems that will accommodate the problem."

- **Solutions available**—There is no need to resort to exotic methods to find a method of reducing the vulnerability of existing facilities and future systems, the scientists said. Fast response, self-healing circuit protection devices "will materially reduce" the damage area. Feasible new transmission systems could be far more immune to electromagnetic effects than present techniques.

At present, the authors said, while strategic and tactical defense/offense forces are designed to withstand tremendous physical shock and radiation levels, "they may not dependably survive the electromagnetic nuclear environment."

Catastrophic electrical and electronic failures—vaporization and ex-

---

Treaty to be Backed by Military Safeguards

THE SENATE Preparedness Subcommittee has promised it will periodically report on whether proper military safeguards are being taken in regard to the nuclear test ban treaty, ratified Tuesday, Sept. 24 by an 80-19 vote.

Sen. John Stennis (D-Miss.) outlined for the Senate a number of points the subcommittee will report on, among them a "schedule for the availability of diagnostic, delivery and sampling aircraft; completion dates for Johnston Island test facilities; commitments on the availability of rocketry and specialized instrumentation for high-altitude and anti-ballistic missile systems tests; information on plans for the acquisition and use of testing ranges; and a clear indication of effective planning for the conduct of annual exercises by the joint task force to perform and to perfect high-altitude and anti-ballistic missile experimentation, if the need and the opportunity should arise."

Stennis also scored the Dept. of Defense for keeping classified the testimony on the military need for the high-yield bomb. He said this testimony "would serve to lay this question to rest once and for all. . . ."

Stennis presented a telegram he had sent to Defense Secretary McNamara Sept. 16 asking that the testimony be released, since other testimony given at the same time against the need for a high-yield bomb had been declassified.

The majority of the 19 Senators who voted against the treaty cited their fear that the Russians had gained knowledge about the weapons effects of high-yield explosions which would give them an advantage over the U.S. until this country acquired the same information.

plosion of electrical conductors, equipment component burnout (especially solid-state devices) and massive insulation failures, and ionization of dielectrics—can be expected in most military facilities that are combined with commercial facilities. From ground zero, they would be affected up to these radii: 1MT fusion, low altitude, 20 miles; 10 MT, 72 miles; and 50 MT, 120 miles. Other scientists predict these effects may reach farther (M/R Sept. 9, p. 18).

Other effects, in a lesser degree, will occur outside these radii. These might include damaged or blown circuit breakers; computer confusion caused by unexpected ground loops, transient pulses and unprogrammed events and instructions, component failure, grounded protectors, blown fuses and disturbance of data-transmission facilities.

The electromagnetic pulse effect, the scientists said, has demonstrated its power in every nuclear test shot. It contributed to most of the instrumentation failures in early test attempts, and continues to cause trouble because systems engineers do not recognize or understand it.

"The effect causes potential changes on conductors in excess of 10,000 volts with rise times on the order of 20 to 100 nanoseconds and durations of one second or more," the West Coast authors said.

In early low-yield fission test activities, failures occurred on powerlines in the area of the tests. Circuit breakers on main feed lines more than 80 miles away opened because of over-voltage conditions. Critics of the test ban treaty, including SAC Commander Gen. Thomas S. Power, expressed fear that the Soviets found out in their high-yield tests that these high-yield electromagnetic pulse effects were even more devastating.

- **Argus tests**—Kuypers said he has been pressing for release of information on EMP since the late 1950's. Through reading stories on Soviet instrumentation of the U.S. tests, the shot times of Argus explosions could be exactly defined. Dramatic and unpredicted electromagnetic disturbances occurred at these times.

The undersea coaxial cable across the North Atlantic Ocean intermittently failed as a result of a low-yield shot at 200 miles altitude. At the same time, critical defense systems suffered outages, but these were not published because of classification.

Examination of other commercial and military communications showed the same correlation. Natural and man-made electromagnetic phenomena daily cause systems troubles, the authors added.

Fusion effects listed by the scientists:

Argus effect—An aurora-like mechanism noted in every high-altitude test, both U.S. and Soviet, which can create a man-made aurora equal to any recorded solar flare storm.

Electromagnetic pulse effect—Can affect buried cable in vicinity as well as aerial facilities. Conductor burnout in the immediate vicinity and high voltages passed down the line to remote electrical/electronic facilities occur from insulation breakdown.

Neutron flux effect—Abnormal voltages are developed in electrical conductors, accompanied by breakdown of insulation from heat, chemical change and electrical stress. Secondary radiation is also initiated along the flux path. This effect may be masked by the electromagnetic pulse effect.

Static discharge effect.—Affects above-ground facilities such as radio antennas, which attract massive electrical discharges from the nuclear fireball edge, much as a lightning rod attracts lightning. Structural components may be melted by these currents.

Radio frequency transmission effects—While not enough quantitive data correlation work has been done in this field, the authors say "Large outages in low-frequency and ultra-low frequency transmission systems have been experienced in connection with nuclear testing, and are to be reckoned with when examining systems reliability in the nuclear environment.

The authors called for a "focal point" to gather all this information together and make it available. While some classified material may be available on a need-to-know basis to systems designers, the problem itself has been hidden, and the sources on the subject are so diverse and "not always in themselves knowledgeable as to the practical results in working systems aspects," they said. ■

House, Senate Confer on DOD Budget

THE DEPARTMENT of Defense appropriations bill is expected to meet final Congressional action sometime this week when Senate and House conferees meet to iron out the differences in their two bills.

Representatives of the two bodies must compromise on a $258-million difference—the House bill providing for only $47.082 billion, the Senate $47.341 billion. Although the Senate originally voted $289 million more than the House, a last-minute reduction of $31 million in procurement was announced by Sen. Richard B. Russell (D—Ga.), chairman of the Defense Appropriations Subcommittee, when the bill reached the Senate floor.

The Senate passed the DOD appropriations bill 77 to 0, but earlier narrowly missed cutting it further on the Senate floor. An amendment proposed by Sen Leverett Saltonstall (R—Mass.), calling for a general 1% reduction in procurement, was defeated by only one vote, 44-43. This measure would have cut a further $157 million.

Also resoundingly defeated was an amendment to cut the bill by $2.2 billion, and another to cut out the $60 million in funds restored for the *Mobile Medium Range Ballistic Missile* (*MMRBM*). This is expected to be a sensitive item in conference, because while the House bill cut $100 million from the Administration request (leaving $43 million), the Secretary of Defense did not request restoration of these funds. However, the Senate put back $60 million after the Joint Chiefs of Staff testified that cutting the funds would set the program back 12 to 18 months.

Still, the feeling expressed by the amendment's author, Sen. William Proxmire (D—Wis.), that he wasn't convinced the Secretary really planned to go ahead with the development of *MMRBM*, is shared by others in Congress.

Failure of the Senate to restore the total amount cut in Air Force R&D probably will result in further stretch-out in the *Aerospace Plane* program, Pentagon spokesmen say. Earlier, DOD said the program would be cut back to $6.5 million if the Senate upheld the general 3% across-the-board reduction in R&D. Although the Senate added $67 million, to the House bill, this was confined to *MMRBM* and a classified project.

The Air Force has implied that a limited amount of effort will continue in some of the advanced categories of development of *Aerospace Plane*. Originally, the $19 million requested for FY 1964 work would have supported efforts in advanced liquid air cycle engines, supersonic combustion, Mach 8 ramjet, an air separator device, turbo-accelerator and advanced structures.

Reaffirmation sought . . .

JFK Proposal Threat to Space Funds

Efforts launched to make further cuts in $5.1-billion figure; officials deny change in national policy; cooperation would be limited

by Hal Taylor

AN EFFORT to cut NASA's Fiscal year 1964 appropriations bill below $5 billion is expected in the wake of President Kennedy's proposal for U.S.-USSR cooperation in a manned lunar landing program.

Although the President is expected shortly to reiterate his commitment to the national goal of landing an American astronaut on the Moon by 1970, the program has already been damaged.

Rep. Albert Thomas (D-Tex.), Chairman of the House Independent Office Appropriations Subcommittee and a supporter of the U.S. space program, has been quietly working in the subcommittee to report out a NASA Fiscal '64 appropriation bill of about $5.1 billion. Previously, Thomas had been successful in preventing deeper cuts by the more conservative full Appropriations Committee, but the President's proposal may ruin his chances this year.

The chairman of the full Appropriations Committee, Rep. Clarence Cannon (D-Mo.), last week was marshalling a Democrat/Republican coalition to cut the budget well below the $5-billion mark when the final committee vote is taken.

The Congressional move to further reduce NASA's budget from the originally requested $5.7 billion was motivated by a belief that the Administration is abandoning the race to the Moon.

• **Efforts to reassure**—Space officials immediately declared that the Kennedy Administration was still committed to landing a U.S. astronaut on the Moon by 1970.

Dr. Edward G. Welsh, executive secretary of the White House National Aeronautics and Space Council, told MISSILES AND ROCKETS that there has been no decision to drop that national policy decision.

Dr. Hugh L. Dryden, deputy NASA administrator, also declared that there has been no change in the nation's intention to be the first on the Moon.

Referring to the President's proposal, Dryden, the chief U.S. negotiator in space cooperation talks with the Russians, said "I think it was an international political move to take the initiative in the area of space cooperation and world peace."

Sympathetic Congressmen believe, however, that the only thing that can prevent further heavy cuts in NASA's budget is a statement by the President supporting the program. An attempt to get such a statement has been made.

Rep. Olin Teague (D-Tex.), second-ranking Democrat on the House Space Committee, has written a letter to the President asking him if the Administration has changed its position *vis-à-vis* the U.S. space program.

An answer is expected shortly. While refusing to speak for the President, Welsh said "I assume the President will state his continued support for the U.S. space program."

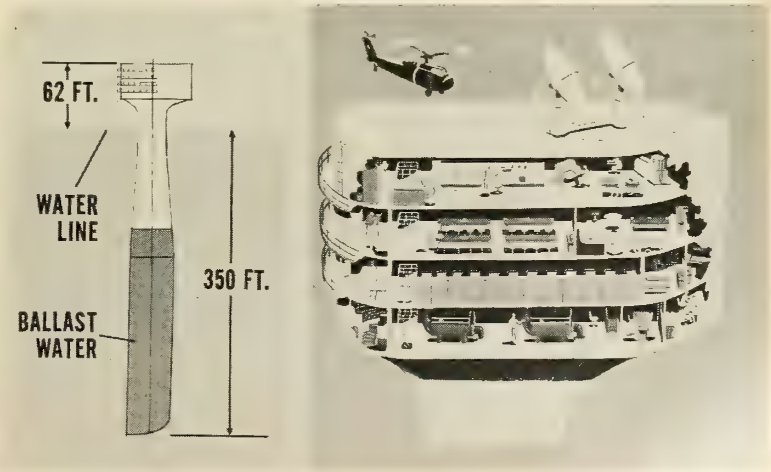
Commenting on the proposal, Rep. Teague said, "I'm very disappointed that it was suggested. I think it is completely impractical."

"Nobody in Congress was even consulted before he made the proposal. Frankly, I think it was a last-minute thought," Teague said.

• **Hard facts**—Despite the confusion surrounding the proposal, both in Congress and among U.S. space officials, at least three things are clear:

1) While the President may have made the proposal for propaganda purposes, some cooperation is possible if the Russians are willing.

Welsh pointed out, however, that "the Government has received no indi-



GD/A's STOP Tracking Station Concept

STABLE OCEAN PLATFORM (STOP) proposed by General Dynamics/Astronautics as a spacecraft tracking system station. Towed to its location in a horizontal position, it would be flipped to vertical by flooding compartments in its hull. Tracking equipment is located on the top deck; second deck is for meals and recreation; third deck contains living quarters; fourth deck power generators.

cation of interest in the proposal by the Soviet Union."

2) At this point, the U.S. position is that cooperation would not involve hardware or putting Russian and U.S. astronauts in the same capsule. NASA Administrator James E. Webb said "our national security would not be involved." This would apparently rule out the exchange of launch vehicle and spacecraft information.

Instead, NASA and Administration officials feel that cooperation should include the exchange of biomedical, space environment and lunar surface information. Such cooperation could include the joint launch of unmanned instrumented probes to the Moon to select a site for a lunar landing.

3) The integration and interface problems between U.S. and Russian launch vehicles and spacecraft would be so immense that such a joint program could not achieve a lunar landing by 1970—the date set by the President in his speech. In fact many officials believe the problems are insurmountable.

There was one major dissenter.

At the conference of the International Astronautical Federation in Paris, Dr. Charles Draper of MIT told M/R that a joint lunar landing was possible within five years, given the present pace and using U.S. guidance with a Russian rocket. But choice of equipment depends on the joint committee if the USSR accepts Kennedy's proposal. The MIT scientist said guidance interface with booster would be less of a problem than structural interfaces. He fears, however, that a joint timetable would stretch out because of relaxation of competition.

Another U.S. scientist told M/R that the Soviet plan for normal-pressure capsule air is possibly better than the *Apollo* plan. In this connection, Dr. William R. Lovelace referenced a survey by Dr. Emanual Roth (M/R, Sept. 23, p. 36).

All U.S. scientists in Paris claimed they were completely surprised by Kennedy's move.

● **No cosmonauts on Apollo**—Dr. Robert C. Seamans, associate NASA administrator, said, however, that he knew several weeks in advance that the President would propose a joint lunar expedition. NASA had been working on a detailed listing of possible cooperative activities. Seamans refused to be more specific than to outline these areas as "tracking, communications, information exchange and scientific research in space."

Both Seamans and Dr. George E. Mueller, director of Project *Apollo*, said that Russian-American space cooperation will not mean cosmonauts aboard the *Apollo* spacecraft.

"There are many other areas for cooperation," Seamans said.

Seamans said the Kennedy offer "definitely was not" any indication of American weakness. "The only way we can negotiate in this matter is from strength," Seamans said.

He again stated that *Apollo* was on schedule, but that there was enough of a "spread" in the NASA launch schedule to allow for "reprogramming of some aspects of the mission."

● **"Thrilling prospect . . . "**—The official NASA position toward cooperation with the Soviet Union on a manned lunar landing program was stated by Administrator Webb in a speech at Houston.

"The President's statement has captured the imagination of the peoples of the world. In itself, cooperation in space activity between the great antagonists of the Cold War is a thrilling prospect." Webb said.

He added that the statement received weight and conviction from the fact that the U.S. now has a powerful space capability; and from the fact that this nation is well on its way to achieving pre-eminence in this new environment. ■

AEC Readies Destruct Tests of SNAP-Type Reactors

AEC WILL BEGIN in November a series of destruct tests of aerospace reactors such as *SNAP-2* and *SNAP-10A*.

The series will be held at the commission's National Reactor Testing Station near Idaho Falls, Idaho.

Its purpose is to obtain data for assessing the safety of nuclear-powered space devices. The data will include the amount of energy released in accidents involving the space devices and the physical, chemical and nuclear phenomena associated with the accidents.

It will also be used to check the results of previous theoretical and analytical studies made of such accidents.

In a previous test in November, 1962, a reactor was deliberately destroyed to get data on what design features enhance a reactor's tendency, when it overheats, to shut itself down.

In 1954, a reactor experiment in Idaho was deliberately destroyed to get data on the ability of a water-cooled and water-moderated reactor, if allowed to get out of control, to shut itself down before excessively high temperatures would destroy it.

● **Designing accidents**—The new test series, designated SNAPTRAN (SNAP Transient), will simulate conditions of several possible accidents that could destroy a reactor of the *SNAP-2/10A* type.

The conditions to be investigated are those that could occur during launch, including premature criticality (start-up) from inadvertent movement of the control drums (beryllium-reflecting mechanisms for controlling reactor operation), or by accidental criticality should the reactor fall into water after failure to reach orbit.

The tests will be conducted by Phillips Petroleum Co., AEC's prime contractor for nuclear safety testing. Prime contractor for design and construction of the *SNAP-2* and *SNAP-10A* reactor systems is Atomics International.

The test series calls for power excursions, including destruct tests, using a beryllium neutron reflector—the normal way of starting up *SNAP-2/10A* reactors—and water reflection of neutrons—the kind of reactor start-up that could occur should the reactor fail to reach orbit and fall into water.

● **Dunking scheduled**—Of principal interest is the water-immersion destruction test scheduled for November, subject to weather conditions needed to insure maximum safety. The *SNAP-2/10A* reactor will be stripped of its beryllium reflector absorbing sleeve. Removal of the sleeve under water is expected to induce immediate reactor core destruction through water reflection of nutrons, thus simulating the maximum credible accident that could occur in water.

The series of SNAPTRAN tests involving a reactor with a beryllium reflector is scheduled to begin early next year. The testing of this reactor will include excursions of increasing severity, ending with a destruct test.

A third series of SNAPTRAN tests is scheduled to begin after the beryllium destruct test and will involve extensive physics testing of a second beryllium-reflected *SNAP-2/10A* reactor at high temperatures. Another destruct test may climax this series.

The tests will be conducted without hazard to the general public or to employees at the testing station. Besides the operating procedure safeguards, the reactors will not have accumulated a buildup of highly radioactive fission products that result from extended reactor operation.

SAE Aerospace Gathering Covers Broad Spectrum

Discussion includes new materials for Aerospace Plane and Dyna-Soar, recovery on Earth and in space of orbital vehicles, booster transportation

LOS ANGELES—In one of the most comprehensive aerospace gatherings of the year, the Society of Automotive Engineers considered topics ranging from traceability and documentation to logistics and transport for space equipment at its national aeronautic and space engineering and manufacturing meeting here last week.

Meeting highlights:

—Successful tests of two new super alloy sheet metals for use at temperatures of 1,700 to 2,100°F to be encountered by *Aerospace Plane*, the *X-20A Dyna-Soar* and hypersonic missiles have been made by North American Aviation. The nickel-base alloys, Inco 713C and NASA TaZ8, were reduced to sheet by a new direct rolling process.

High-strength superalloys are dense, so applications for them require some such means of producing thin sheet and foil which can be built up into complex lightweight structures such as honeycomb. They are free of the severe oxidation problem of refractory metals. Inco 713C and NASA TaZ8 can both be welded with an inert gas-shielded tungsten arc, according to preliminary test results.

The NAA development was reported by Herbert Greenwald, Jr., and Thomas J. Riley.

—Cladding of foil gage superalloy sheet to protect it against oxidation at 1,800 to 2,000°F is still regarded as promising by Lockheed-California Co., despite experimental results that show it fails to protect against some other effects of high temperatures. The experimental specimens were René 41 sheets clad with Inconel, Hastelloy X, and nichrome manufactured by a process simulating production cladding.

Good oxidation resistance was obtained with all of them, but diffusion at the interface between cladding and substrate permitted the loss of hardening elements from the René 41 and a resultant deterioration of its properties. Lockheed researchers M. G. Childers and R. F. Simenz suggest that a cladding alloy with a high content of these hardening elements, such as Inconel 702, might defeat the diffusion problem.

—Electric motors submerged and perhaps wetted in liquid gases would have the advantages of low resistance and exceptional cooling in such missile and space applications as pump drives for cryogenic fluids or for gas fans and blowers.

Tests by the Pesco Products Div. of Borg-Warner Corp. indicate that it is feasible to operate electric motors with their internal parts immersed in liquid hydrogen or nitrogen. Motors designed for this condition produce more horsepower per pound and are simpler and more efficient than "unwetted" motors, according to J. H. Redmond and F. W. Bott, who conducted the tests.

—The minimum-weight water-recovery system for spacecraft would be a combination of parachutes and retro-rockets for deceleration just before touchdown.

- **Retro-rocket effects**—A General Dynamics/Astronautics study by K. M. King has investigated some of the questions raised by retro-rocket ground effect at low altitude, and the scooping out of a cavity in the water surface by the retro-rocket exhaust. The ground effect of the reflected exhaust produces a beneficial increases in effective thrust. However, it increases in a variable manner which is hard to predict, and it may produce an overturning tendency.

The latter possibility should be the subject of separate model tests. The blasting of a cavity in the water surface can result in improved dissipation of the impact. But care must be taken that the shape of the cavity does not match the shape of the spacecraft impact surface. This would cause high impact deceleration and pressure.

—A Martin Co. survey of factory-to-launch transport and handling of future large launch vehicles estimated that a representative space vehicle of tomorrow would stand 445 ft. high and weigh 2,750,000 lbs. empty. The stages, and perhaps the spacecraft itself, would be manufactured and transported in the vertical position.

- **Water transportation vital**—Beal M. Teague, project engineer, advanced programs, Denver Div., said the study ruled out proposals that such large vehicles be manufactured at the launch site. This would involve a very low launch rate and, consequently, a great number of pads that would have to be located several miles apart.

In view of this and the fact that vehicle sizes will preclude overland transport for any appreciable distance, manufacturing facilities must be accessible to navigable water. For liquid stages, savings in crane capacity and cost can be realized if the vehicle is assembled vertically on a final assembly fixture that is mounted on the deck of

Martin techniques for solving the problems of life support in space

1. **In Martin equipment studies,** we test safety and operation of protective clothing in environmental control chambers which provide a wide range of temperature variations. Mounted over a variable spee variable pitch treadmill, this chamber checks equipment under conditions of exertion as well as repose.

2. **In Martin simulators,** we put men through rigorous computer-programmed "flights" which duplicate every condition of a space mission but weightlessness. Purpose: to evaluate man's performance under these conditions and to verify the sub-systems he needs to assure completion of his mission.

3. **In Martin life science laboratories** we are developin and testing reliable systems for maintaining a breathable atmosphere. Shown here is GIPSE, a fully instrumented Photosynthetic Gas Exchanger, being installed in the passenger pod of a space vehicle for actual test in space. Successful test flight took place in March, 1963.

4. **In Martin design studies,** we conduct detailed tests for optimum control cabin configuration. Pilot shown here is running a simulated lunar landing problem using an in-place diagram of one possible control panel arrangement.

5. **At Martin's Rendezvous Laboratory,** we use full-scale computer-programmed simulators to develo precision techniques for rendezvous of orbiting spacecraft. Triple exposure shows progress of spacecraft making approach and closure for dockin under simulated space conditions.

These are just five examples of the techniques we use to provide answers for life support in space, where man is the prime system. Current Martin research includes the basic li sciences, the development and application of equipment and instrumentation, the chemistry physics, metallurgy and mathematics of life support, and the entire broad area of Man-Machine Integration. Our extensive range of facilities and capabilities gives us the unique opportunity to integrate all aspects of the problem. Life support is an area of major capability at Martin.

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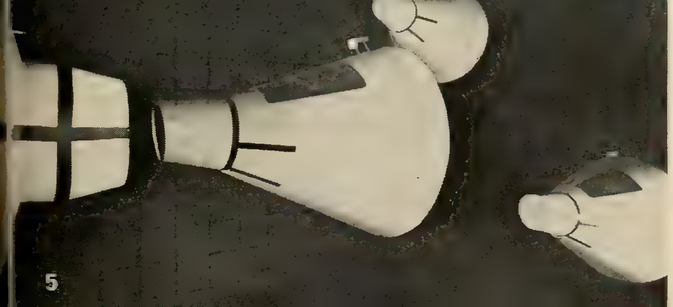
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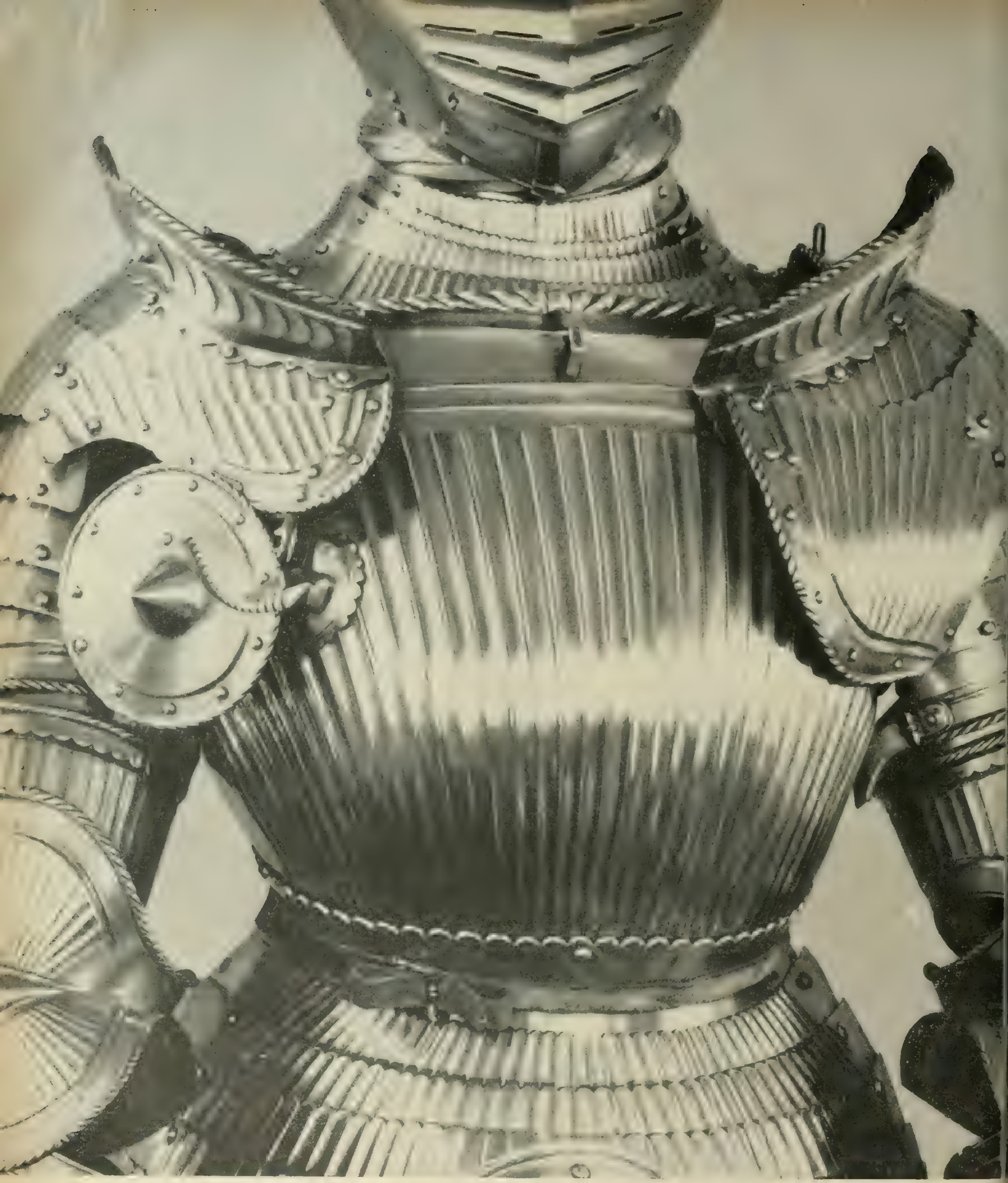

Photo courtesy Higgins Armory and Worcester Pressed S

Need a bodyguard?

ROKIDE® ceramic coatings offer unusual protection! Right now ROKIDE "A" is being used as a thermal bodyguard for the titanium nozzle extension on Textron's Bell Aerosystems Agena liquid rocket engine — "workhorse of the space age." And ROKIDE "C" is protecting suction box covers on high-speed paper-making machines from costly abrasion and wear.

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a stabilized barge.

If assembly is done on land, savings can still be realized if the final assembly fixture serves as a transporter as well as a structure for captive testing or launching. Transport of very large verticle structures by barge poses critical considerations with regard to wind.

—Goodyear Aerospace Corp. presented a parametric study of orbital recovery of manned vehicles with expandable pressurized drag bodies.

F. R. Gross, Goodyear engineering specialist, said the study showed it is feasible to eliminate the ablation heat shield in favor of a drag body. Advantage would be lower re-entry temperatures, since heating occurs at higher altitudes where the atmosphere is less dense. Payloads equal to 70 to 76% of gross weight can be recovered with drag balloons constructed from theoretical minimum gage René 41 fabrics.

Recovery of payloads equal to 60 to 68% of gross weight can be accomplished with balloons constructed of available fabrics. Balloons would be inflated with pressurized helium. Landing velocities vary between 25 and 75 fps, so that landing attenuators—such as parachutes or retro-rockets—probably would be necessary only for the larger payloads, Gross said.

—The solar thermionic system can become a strong competitor for future space application if efficiency can be improved by at least a factor of two, D. L. Dresser of Allison Div., General Motors, reported.

Theoretical and experimental results during the past four years show the system probably is limited to 5 to 10 kw output power by the requirement for a precision solar concentrator. In comparison with the solar cell system, the thermionic system may find application because it is not subject to radiation damage, and may have a lower specific weight and cost.

Certain design goals must be achieved first, however, including improvement in efficiency to at least 20% for high-temperature operation (2,000° K), an orientation error of ±2 min., and a feasible energy storage material to enable significant weight saving.

—Use of uninsulated liquid hydrogen upper-stage tankage appears to be impractical, according to an analysis by Thiokol Chemical Corp.'s Rocket Operations Center.

Wolfgang Schaechter, head of aerothermodynamic analysis, reported that the problem could be met with use of an 0.050-in. layer of corkboard insulation on the surface of the tank, reducing by more than 90% the predicted pre-launch boil-off of 15 to 16% of the initial mass of hydrogen during first-stage flight, before ignition of the liquid hydrogen upper stage. ■

Tighter control . . .

Navy Sets December Target Date for Management Overhaul

by David C. Breasted

THE NAVY is proceeding under forced draft to lay down "by early December" a McNamara-style management plan affecting its entire program of weapons programming, development and procurement.

The scheme is designed to give the Navy more effective machinery for systems and project planning and management by setting up tighter control between the Bureau level and the Secretary of the Navy.

This, it is hoped, will yield the Navy more for its money, and enable it to improve its homework for the Defense Department administration.

Officials working on the plan also figure the new machinery will be more responsive both internally and to industry.

The Chief of Navy Material, newly designated and more authoritative overseer of four key bureaus, was significantly described last week as "responsive to the Chief of Naval Operations, but responsible to the Secretary of the Navy."

Industry, confronted with the frequent complexities of crossing bureau lines, "was beginning to pad the halls of the CNO," as one observer put it.

To the new CNM, Vice Adm. W. A. Schoech (pronounced "shay"), has gone the job of organizing and oiling the new machinery above the operating bureaus, aided by a staff of high-level project managers at his right hand.

Schoech, commanding the Navy's prime "producers," will maintain and improve responsiveness to the CNO's "users," while giving Navy Secretary Korth and DOD a clearer picture of Navy weapons procurement.

At Adm. Schoech's other hand is Rear Adm. Eli T. Reich (pronounced "rich"), deputy chief for programs and financial management, a pivotal post in the scheme.

Ranged at the next echelon in the present formative process are deputies for development, materials and facilities, and management and organization.

On the working level, remain the four main bureaus: Weapons, Ships, Yards and Docks, and Supplies and Accounts.

• **Easing burden**—Officials last week stressed that the bureau chiefs will not only remain the operating executives of the set-up, but may find their jobs made easier through better coordination above them and between resource allocations and activities of the individual bureaus.

The management "adjustment," as its planners prefer to call it rather than reorganization, is largely above the bureau level.

Industry will continue to deal with the bureaus directly on contracting.

In the scheme within the CNM set-up, the project managers under Adm. Schoech will deal only with projects of greater complexity and expense which cross bureau lines.

In this connection, the Surface Missile System Project Office will report to CNM.

Development of smaller missiles such as *Sidewinder* would still be handled by project managers within BuWeps.

The CNM plan is part of a larger scheme calling for establishment in the Secretary of the Navy's office of an Office of Program Appraisal paralleling at that level the appraisal system of the Secretary of Defense in applying the Administration's cost-effectiveness standards.

The CNO and Commandant of the Marine Corps will also have plans and programs offices. The CNO unit is intended to insure that the Navy adheres to the five-year program package management concept, a function that CNM will further in its sphere.

• **Wounds healing**—The whole far-reaching scheme of reorganization was not born without birth pangs, and its final details are not yet firm. It grew out of the so-called Dillon Report released earlier this year which was sharply critical of how the Navy Department was run in some fields. It was particularly critical of the frequently disjointed relationship between programming and funding.

Some Navy conservatives were miffed because they felt that the CNO's status was jeopardized. Adm. Claude V. Ricketts took a dim view of the proposed CNM echelon between the bureau chiefs and CNO.

Others in the anti-McNamara camp feared the effects of having those in charge of the huge weapons development and procurement programs answerable largely to civilian leadership. But the reorganization planners think that the organization is coming around to the fresh approach. ■

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Selection due next month . . .

New Astronauts To Provide Manpower for Three Lunar Landings

by Warren Burkett

HOUSTON—Manned Spacecraft Center directors are conducting the final review of applicants for the astronaut pool here. Astronaut Coordinator Donald K. Slayton says 26 to 30 candidates have been interviewed, and it is hoped that the new pilots will be named early next month.

"The next group should take us through the third lunar landing," Slayton said. Five Moon landings are planned.

The new astronauts will automatically come under a $2-million, four-year contract for personal story rights, which is now nearing approval in NASA headquarters. The contract, due to expire Aug. 31, 1967, has a four-year renewal option.

Total amount the astronauts will receive was nearly halved from the figure originally submitted for headquarters approval. Field Enterprises Educational Corp. of New York will pay more than $320,000 yearly for newspaper and book rights. Time, Inc., and *Life* magazine will pay no more than $200,000 annually for magazine rights.

- **Tax advantages**—The contract provides each astronaut and his family with $16,200 more than their yearly military and civil service pay and privileges. For tax purposes, payments will be divided between the astronauts and their wives and children. Of the total, Field will pay each man and his family $10,000, with the rest coming from Time, Inc.

The new contract does not include radio, television or movie rights. Astronauts may write for and be photographed by "non-competing media," a source said. They may appear on public service TV, radio, movies and recordings.

Under the payment ceiling negotiated in the new contract, the terms would cover 31 astronauts, the maximum number NASA has announced it will select for *Gemini* and *Apollo.*

Slayton said the new pilots would provide a sufficient astronaut pool for present programs. Other programs would require new pilot-pool members.

Astronaut candidates selected for the third group will come mainly from graduates of the Aerospace Research Pilot School, as have seven of the current 16 astronauts.

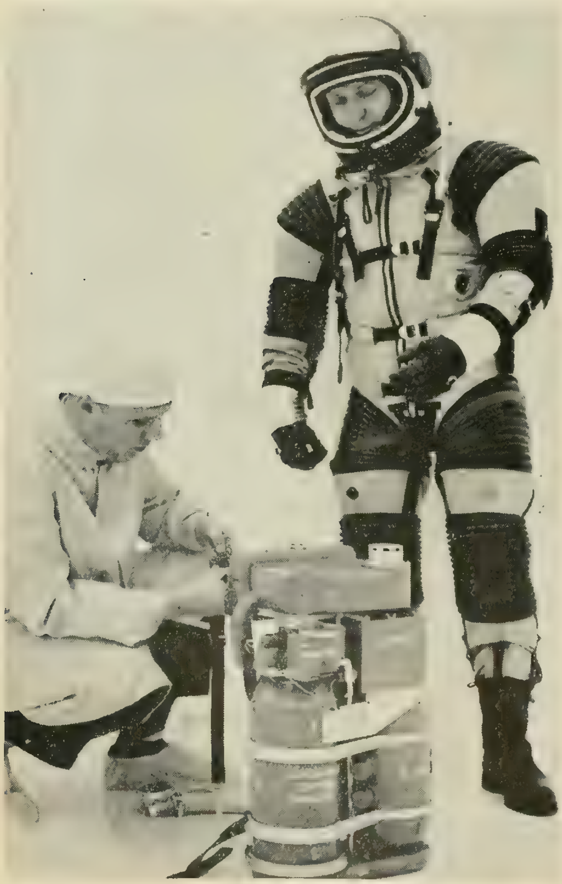
- **Scientists considered**—At the Edwards AFB school, however, a different philosophy of space pilot training is being incorporated into the curriculum.

Col. Charles E. Yeager, school commandant, proposes to admit research scientists and engineers with little or no jet flight experience. In the beginning, the scientists would ride the second seat on the reaction-controlled fighters being assigned to the school.

"We've considered this many times," Yeager said in an interview. "We took in Capt. James Roman, who was a doctor and engineer. He was a pilot too. He did a hell of a good job.

"Right now we're pretty young in space experience," Yeager noted. "You are limited in crew space, and you need every qualified person to get up and get back. But I agree with the scientists that you can take a man experienced in his field and train him to fly. It is easier to train a man in the space environment than it is to give an astronaut training in this specialty field. You can't exceed the skill of a geologist who has spent years learning his specialty."

He will propose the idea formally for the next class at Edwards. ■



Apollo Spacesuit Mockup

INTERNATIONAL Latex Corp. mockup of Apollo spacesuit is shown along with portable life-support system. The life-support system consists of a power supply to run fans that will circulate air and operate communications system. Other tanks hold gases and four-hour oxygen supply. Unit can be re-charged in Lunar Excursion Module.

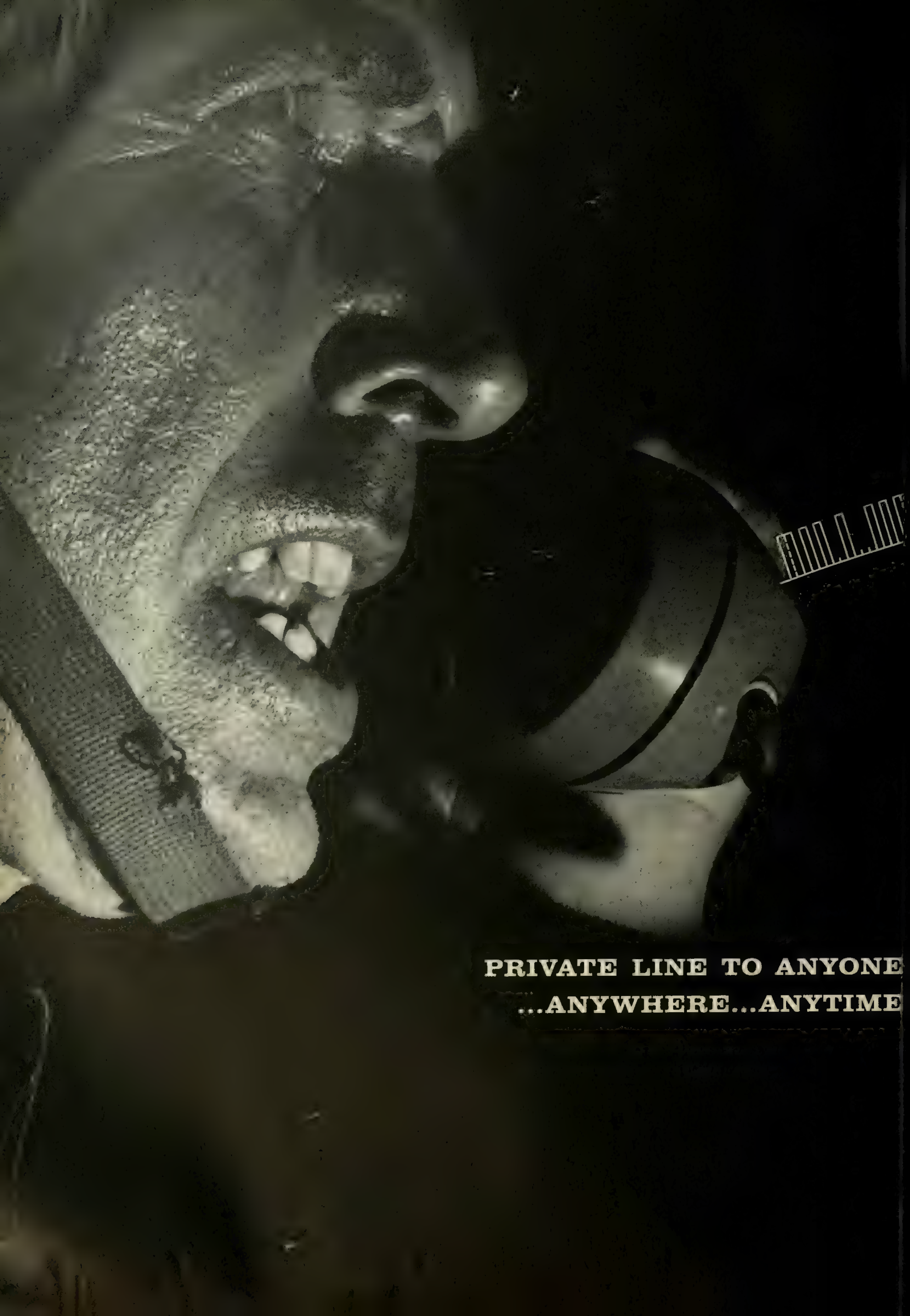
THE QUIET MEN AND THE MINIATURE REACTOR One of man's strongest motivating forces is his need to know. It is part of the sense of wonder in a child's eyes—an inborn desire for the answers that will add up to maturity. It is also a source of inspiration for the research scientists of America's aerospace industry.

Today—quietly—certain of these specialists are advancing down the byways of nuclear research, through the unknown realm of the universe, and into the very cosmos where facts and philosophy blend. Along the way, they find more new questions than answers. But already their answers are bearing fruit—for example, miniature new SNAP reactors from NAA's Atomics International Division, with myriad uses on earth, in space, and on the moon.

Research scientists like these are the explorers of the new Age of Space. Seekers for the headwaters of knowledge. Trail breakers whose unerring sense of direction can lead mankind to new plateaus of well-being.

These are the quiet men.

North American Aviation is at work in the fields of the future through these divisions: Science Center, Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.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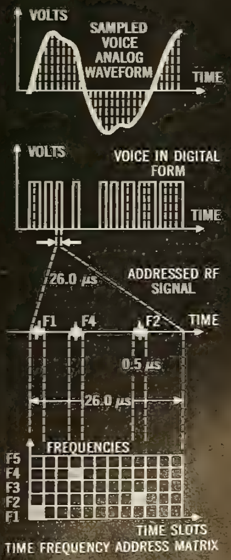

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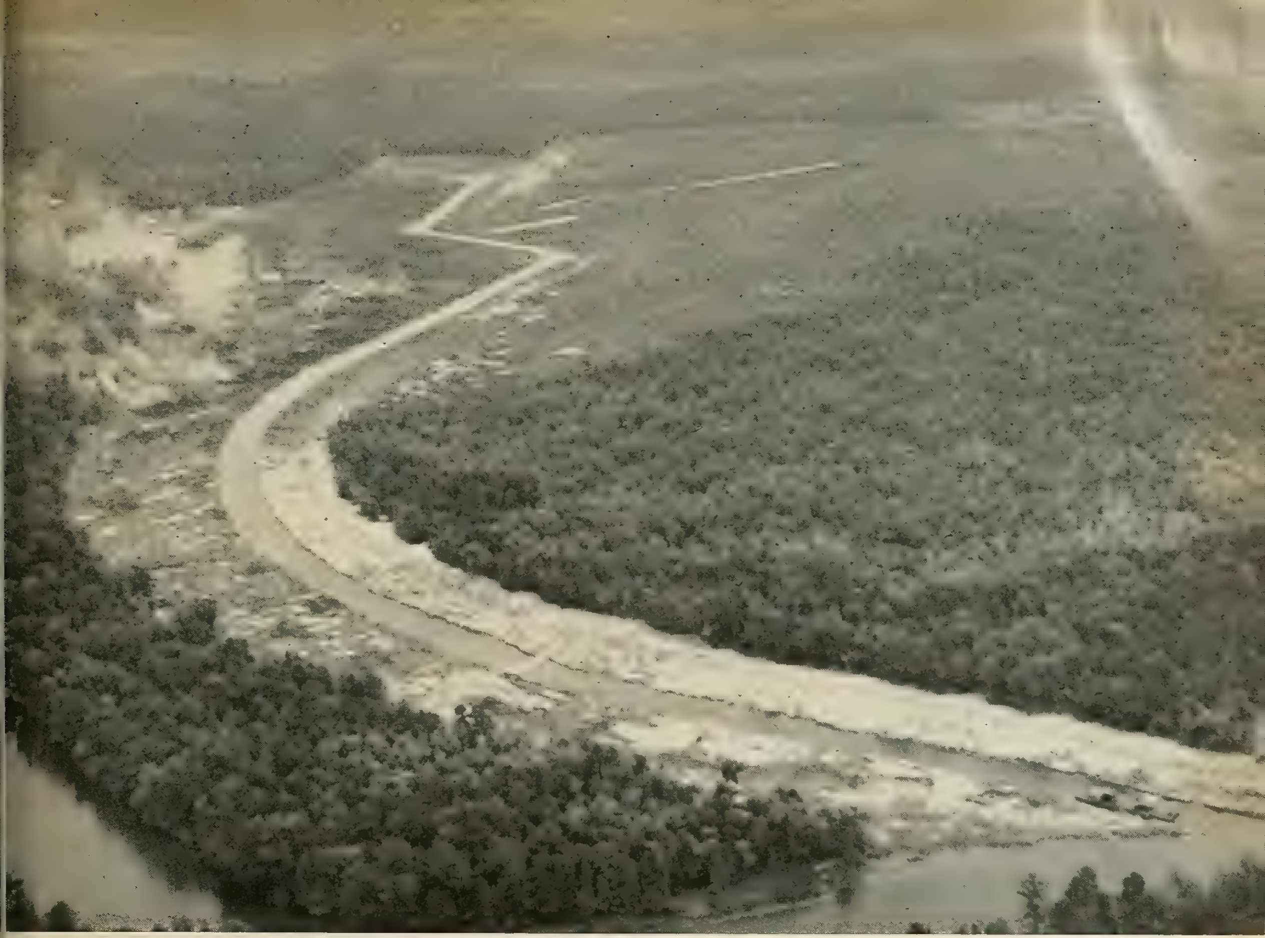


A CHANNEL curves to link East Pearl River (foreground) with the Mississippi Test Operations site in the background. The channel ends at the point where dredges are cutting out a harbor. Test sites will be constructed at upper right.

For Saturn V testing . . .

Mississippi Facility's First Firing Set for Summer of '65

by Chris Butler

Picayune, Miss.—A $500-million space age Venice, where giant rockets will glide along a network of canals, is being built near here in a slash pine forest.

When completed in 1965, the Mississippi Test Operations of Marshall Space Flight Center will be capable of completely testing the S-IC and S-II stages of the *Saturn V* lunar rocket.

Construction contracts will be awarded soon for laboratories, inflammable materials storage facilities, warehouses, a central control building, a data handling center, second stage storage and administration buildings.

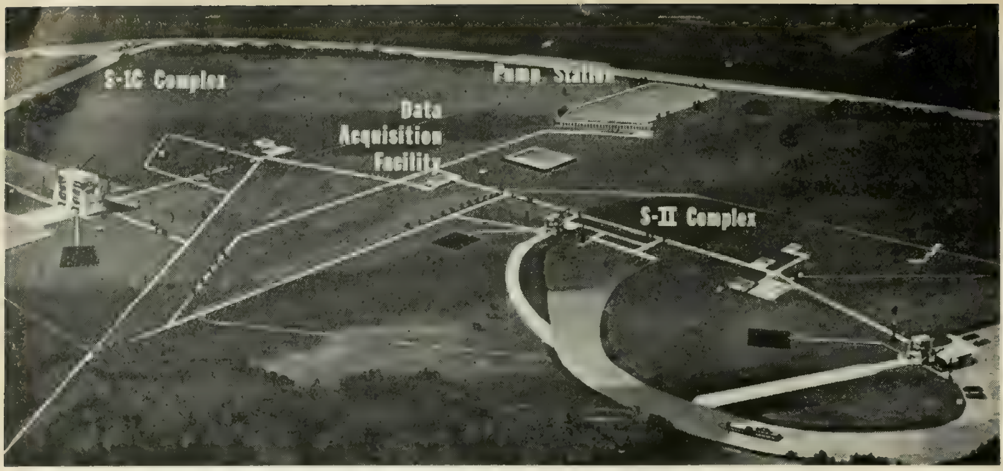
Test stand construction plans call for separate units to test-fire the S-II stage, but a single, two-position test stand is planned for the S-IC first stage of *Saturn V*.

The stand for the 1-million-lb.-thrust S-II stage is scheduled to be completed first, and the center's first test firing is now expected during the summer of 1965. The first test unit will be built at the end of the branch canal to prevent interference with construction of the second unit, which will not be finished when testing gets under way.

The dual-position S-IC stand is scheduled to receive its first 7.5-million-lb.-thrust stage for testing in the fall of 1965. Testing will begin before the end of the year.

- **Sound dispersal**—Stand designers have incorporated an innovation to help solve noise problems created by big boosters. Part of the vertical portion of the flame deflector will be left open so sound can move freely in all directions.

Forests will be left standing wherever possible because the limbs, trunks, leaves and needles of trees can absorb great amounts of noise.



DETAILS OF Advanced Saturn complex at Mississippi Facility.

• **Data handling**—Data from test stand operations will be collected and transmitted to a central data acquisition center over a system being designed and provided by Aetron, a division of Aerojet-General Corp., under an $18,524,800 contract awarded this summer.

The data will be relayed to a data-handling center for quick readings before they are sent to a center for complete reduction and detailed analysis. This work may be done at the MSFC computer center in nearby Slidell, La.

This equipment will be operated by personnel of General Electric Co., which on Sept. 4 received a contract for $2,393,500 to supply support services to the center for one year.

GE will provide plant support and test support. The former includes plant security, fire protection, medical facilities, plant maintenance, transportation, reproduction and graphic arts.

Test support will cover control and command systems, support services for data acquisition and handling, engineering services, a component service facility and shop and field services.

• **Future plans**—While the current build-up includes only test stands for the S-IC and S-II stages, Marshall Space Flight Center planners have fixed locations for future testing of other engines and rockets.

NASA spokesmen at the test center said NASA's budget for Fiscal 1965 will include a request for funds to construct a dual-position test stand for the S-I stage of the *Saturn I* series.

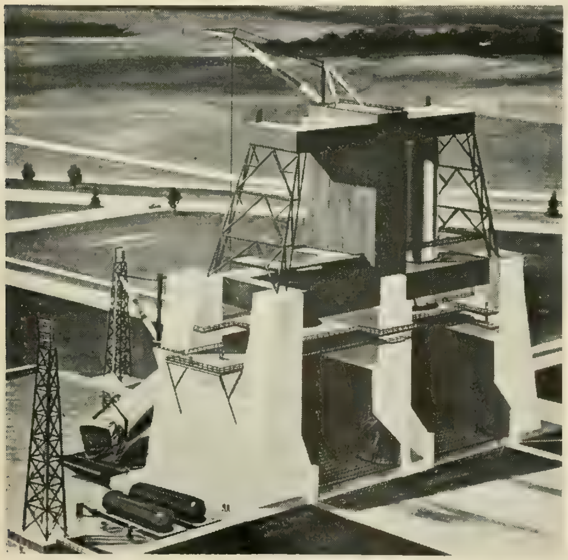
Manager of the test center is Capt. William C. Fortune, a Navy officer detailed to NASA. His executive assistant is John S. Hilburn, who formerly served as the Mississippi Test Operations liaison officer in Huntsville.

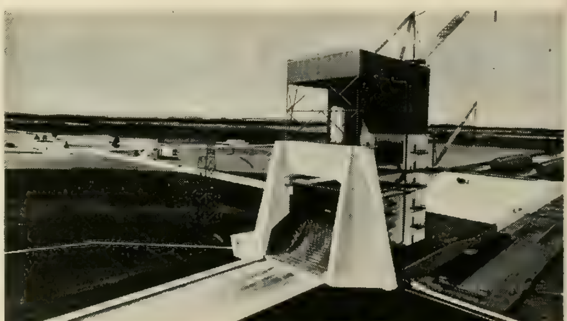
The need for a test area along the Gulf coast became apparent when NASA decided to reactivate the old Michoud plant in New Orleans and use it for assembly of *Saturn* boosters.

Acquisition of land started soon after NASA announced on Oct. 25, 1961, that the test center would be located south of here along the East Pearl River. It includes a central 13,500-acre test area and a surrounding 128,000-acre buffer zone.

The site was selected because it is close to the Michoud plant, the land was sparsely settled and the East Pearl is navigable all the way to the Intracoastal Waterway, the route used to transport Saturn boosters to Cape Canaveral.

Although land acquisition started much earlier, the first contract for the facility was not awarded until Oct. 15, 1962, when a firm was selected to build a temporary acoustical laboratory. ■





TEST STAND for Saturn V's S-IC stage (above), and for S-II stage (left). Booster stages will be brought to stand via canal system, part of which appears adjacent to S-IC stand.

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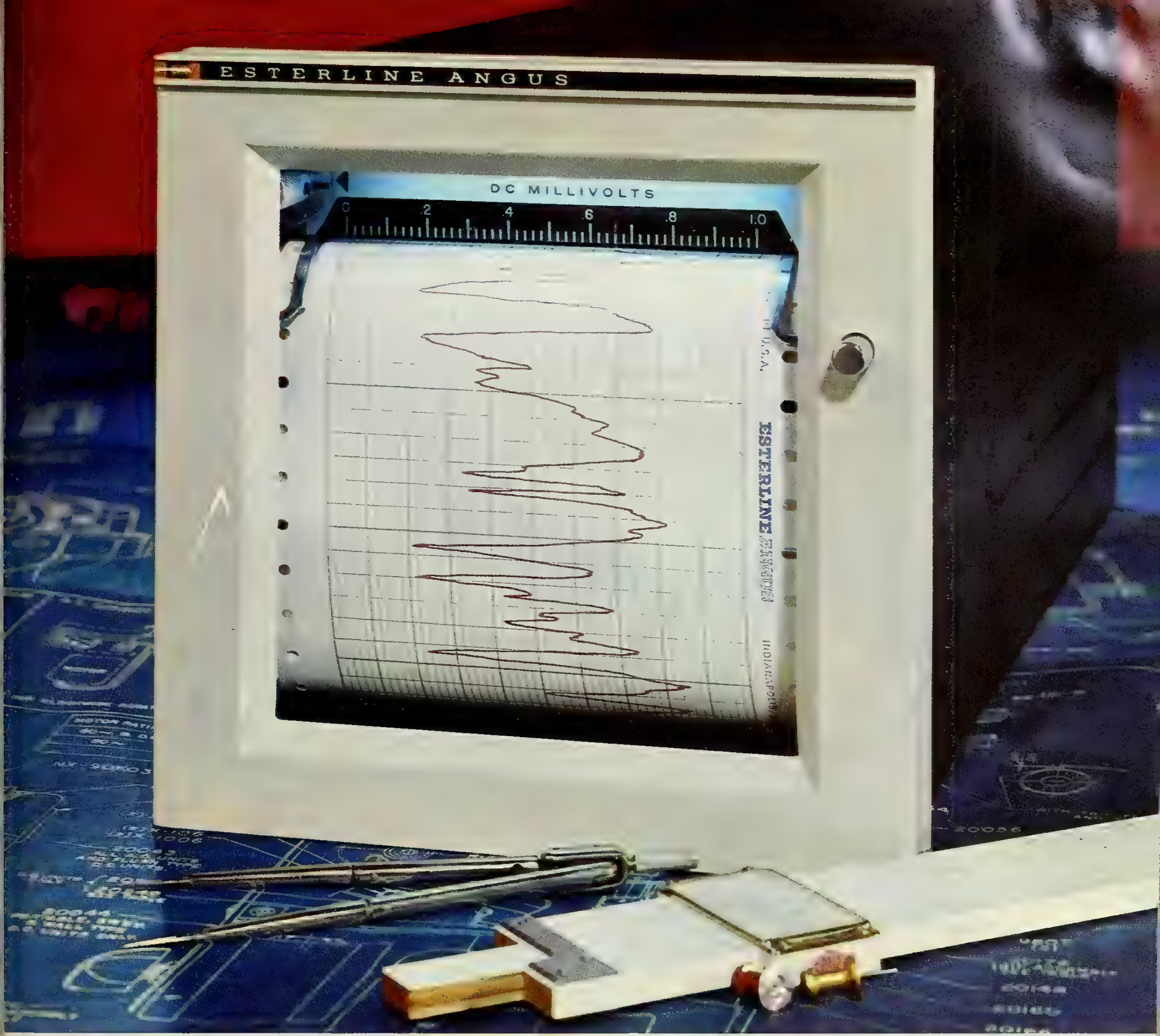

(Illustrated: Flush recorder with 8″ x 8″ front. Portable "Labgraph" also available.)

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Technical Countdown

ELECTRONICS

Radiation-proof, High Temp Circuits Near

Scientists at Melpar, Inc., may be reaching the end in their search for radiation-resistant, high-temperature thin film circuits. A recent series of tests conducted on vacuum-deposited flip-flop circuits at radiation levels approaching the maximum output of the Hughes Aircraft linear accelerator failed to alter the state of the circuits. Passive elements have been developed operable to 500° C, and active devices consisting of cadmium selenide field-effect transistors currently function to 200° C. In the radiation tests, comparable single-crystal circuits change state under fields a thousand times less intense. The program at the Westinghouse Air Brake Co. subsidiary is funded by Navy BuWeps.

Proton Flux Prediction

Increases in solar flare proton flux hazardous to manned spacecraft can be forecast 21 to 35 days in advance, reports Dr. J. B. Weddell, Space and Information Systems Division, North American Aviation. Based on magnetic and optical measurements of active regions on the Sun's disc, the predictions have a 79% probability of being accurate. Probability that a warning will turn out to be false is 4%. Measurements proving the feasibility of flare prediction were made by the Sacramento Peak, McMath-Hulbert, and Mount Wilson observatories. Optical characteristics of calcium plages and the line of sight component of the photospheric magnetic field are the chief parameters required.

Data Center Opens at Marshall

Marshall Space Flight Center has opened a new data switching center. The facility is the result of coordinated effort by the Computation Laboratory, Management Services Office and the International Telephone and Telegraph Co., furnishers of the equipment. Heart of the system is an ITT ADX (Automatic Data Exchange) 7300, which collects and transmits data and switches data circuits to high- or low-speed digital, facsimile, teletype, video, telemetry data and others. The center combines line switching (as in plugging in telephone lines at a switchboard) and message switching. The center can store information and forward it to the proper outlet at some future time.

ADVANCED MATERIALS

Metal-Organic Resins Marketed

A series of metal-organic resins capable of being handled as conventional resins is being marketed by Thermo-Resist, Inc., Fullerton, Calif. The compositions have been designed to enhance the properties of reinforcements as decomposition occurs through eutectic formations at elevated temperatures. The metal-organic resins are designed for use on high silica glass and other oxides and reinforcing media where the reactions can occur when exposed to high temperatures. The first series is chromium based and consists of a chrome-phenolic (Chrome-P), chrome-epoxy (Chrome-E), and a chrome-siloxane (Chrome-S).

Small-Tube U-V Inspection Possible

Boeing has developed an improved inspectroscope permitting visual inspection of tubing less than 0.5 in. in diameter. Using fluorescent materials and ultraviolet light, Boeing engineers have inspected interiors of tubes as small as 0.4 in. in diameter and up to 9½ ft. long. Tubing is first bathed in fluorescent penetrating oil, then rinsed. Penetrant remaining in cracks or defects glows under ultraviolet light. The system transmits light to tube interiors with the light traveling through hollow probes of various sizes inserted into the tubes. Moving vertically from its sources, light strikes a miniature mirror set at a 45-degree angle in the probe mount and bounces horizontally to another 45-degree mirror at the front of the probe. By rotating the probe and its mirror, an inspector can cast light a full 360 degrees inside the tube.

High-Velocity Extrusions Available

The Westinghouse Materials Manufacturing Div., Blairsville, Pa., is accepting orders for custom-made, Dynapak extrusions in titanium alloys, all types of tool steels and stainless steels. The extrusions are made on a press at the rate of 500 linear in. per second with rounds, squares, rectangles, Y's and T's for cross-sectional shapes. The minimum thickness in large quantities is 0.050 in., maximum straightness and camber is ⅛ in. in five ft., and the maximum twist is 0.25 degree/ft. Cross section size is limited to the configuration circumscribed by a 2-in. circle. Length is a function of the reduction ratio and is determined by the cross-sectional area. The maximum dimension is the transverse direction.

Large Area Electrochemical Machining Possible

Researchers at the IIT Institute have demonstrated the feasibility of making integrally-stiffened structures for *Nova*-class vehicles through electrochemical machining methods. The technique would eliminate the cumbersome mechanical machining normally necessary for such massive pieces of metal. Dr. Howard T. Francis and his team determined the conditions allowing the sinking of a 10-in. square cavity at the rate of 0.1 to 0.2 in. per minute. This means that it will be possible to sink cavities in a waffle pattern on the massive skins of huge boosters through electrochemical machining tooling. The end result is a thin skin supported by ridges equalling the original thickness of the metal plate used.

PROPULSION

Saturn Ground Wind Effects Studied

The effects of ground winds on the huge *Saturn* boosters while in the launch position are being investigated by Martin Co. under a $130,000 NASA contract. Because of the vehicle's size, it is believed that ground winds may cause severe oscillation, forcing delay of the launch or even destruction of the vehicle. One aspect is the shape of the payload. Martin experts long ago discovered that certain payload shapes virtually eliminate the wind-induced oscillation problem.

LEM Propulsion Facility Under Contract

Burns and Roe, Inc., will design a new propulsion test facility for the Corps of Engineers to be installed at NASA's White Sands, N.M., facility. The test complex will check out the engines being built for the LEM and the facility is scheduled for completion in late 1964. The fully instrumented test chamber will have more than 700 channels available for checking engine performance and another 150 will determine and record pressures, temperatures and other operating conditions within the engine chambers

Fishing around for new materials?

Aluminized glass fabric can make a whale of a difference especially if you're looking for increased heat resistance and bellows type of folding. ☐ CHR's Custom Group is working daily with the latest in materials technology. This thermal radiation shield is fabricated from aluminized glass fabric which is coated with silicone rubber for extreme heat reflectivity and foldability. An imaginative design of folds and wire stays satisfies the practical requirements of coverage, setup speed and limited storage space. ☐ Don't flounder around in a sea of obsolete materials. CHR's line can add allure to your products and wind to your sales. Connecticut Hard Rubber Company, New Haven, Conn.

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to come
are
formed
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'Poor Man's Launcher' May Encourage Non-Space Nations

Cubic Corporation's 'Forester' is capable of placing 100-lb. payloads in low-Earth orbit at roughly $700,000 per shot

by William Beller

DO-IT-YOURSELF space kits enabling their buyers to loft 100-lb. payloads into low-Earth orbits are being offered for roughly $700,000.

No security strings are attached to this space-age package, including ready-for-launch vehicles as well as flight-test programs and ground-support equipment.

Called *"Forester"* and described by the Cubic Corp of San Diego, its developer, as "an economy-fare satellite-launching system," it is seen as an inexpensive way for a country to buy into the space business.

Cubic Corp. says *Forester* could help scientists from "non-space" nations contribute space data during the IQSY (International Quiet Sun Years).

Technological uses in the communications and meteorological fields are foreseen in addition to industrial and commercial uses by U.S. concerns.

- **Off-the-shelf motors**—Motors for *Forester* come from Thiokol Chemical Corp. H. W. Ritchey, company vice president, says their costs are kept down by selecting appropriate units from approximately 80 motors in the company's "off-the-shelf" inventory.

Result: *Forester I* and *Forester II*, each a four-stage vehicle of solid propellants but differing performance. Common motors are used because "(they) reduce the required investment in ground-support and ground-handling equipment," says Ritchey. "Also, common motors . . . sharply increase the learning curve for checkout and launching crews."

On this basis, the upper stages of both *Foresters* are the same. The first stage of *Forester II*, however, has two Aspen motors instead of the single Aspen in *Forester I*.

Forester II typically can place a 100-lb. payload into an eastward low Earth-orbit and *Forester I* can place 50 lbs. into a slightly inferior orbit.

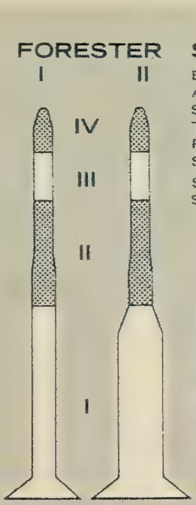
- **Flight profile**—Each *Forester* is launched vertically. After a short flight, when the speed reaches 50 fps, the vehicle is tipped to an angle-of-attack preset in the automatic pilot. Controls are then returned to neutral, and the vehicle turned "into the wind" until the angle-of-attack drops to zero.

A gravity turn is then flown until after third-stage burnout. Before the stage is separated, though, the autopilot orients the vehicle so that the satellite—after fourth-stage burnout—is injected into the desired orbit.

- **Cheaper by tens**—Organizations

STAGE IV	Weight in Pounds	
CEDAR	530	
MOTOR SUPPORT	18	
HEAT SHIELD	45	
STAGE SEPARATION	13	
SPIN. MOTORS	2	
TRANSPONDER POWER SUPPLY & ANTENNA	10	
WEIGHT AT IGNITION		618 lb + PAYLOAD

STAGE II		
ASPEN	8,850	
REACTION CONTROLS	410	
STAGE TRANSITION	150	
DESTRUCT SYSTEM	30	
STAGE II WEIGHT	9,440	9,440
STAGE III WEIGHT		3,042
STAGE IV WEIGHT		618
WEIGHT AT IGNITION		13,100 lb + PAYLOAD



STAGE III	Weight in Pounds	
BIRCH	2,870	
AUTOPILOT	25	
STAGE SEPARATION	15	
TELEMETRY PACKAGE	20	
REACTION CONTROLS	90	
STAGE TRANSITION	22	
STAGE III WEIGHT	3,042	3,042
STAGE IV WEIGHT		618
WEIGHT AT IGNITION		3,660 lb + PAYLOAD

STAGE I	FORESTER I	FORESTER II
ASPEN	8,850	17,700
AFT SKIRTS & SUPPORTS	190	400
AERODYNAMIC FINS	250	300
REACTION CONTROLS	410	800
CLUSTERING STRUCTURE	0	300
STAGE I WEIGHT	9,700	19,500
STAGE II WEIGHT	9,440	9,440
STAGE III WEIGHT	3,042	3,042
STAGE IV WEIGHT	618	618
WEIGHT AT LAUNCH	22,800 lb.	32,600 lb + PAYLOAD

Table of Forester Weights

WHAT NEW LABOR LIES AHEAD?

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HERCULES

XP63-3

	PAYLOAD (POUNDS)	LAUNCH DIRECTION	APOGEE (MILES)	PERIGEE (MILES)	ORBIT PERIOD (HOURS)	LIFETIME (YEARS)
FORESTER I	[illegible]	EASTWARD	[illegible]	[illegible]	[illegible]	100
	[illegible]	POLAR	[illegible]	[illegible]	[illegible]	3.5
	[illegible]	EASTWARD	460	300	1.65	8
FORESTER II	50	POLAR	1130	300	1.86	100
	[illegible]	EASTWARD	1460	300	1.98	100
	75	POLAR	450	300	1.64	7
	100	EASTWARD	800	300	1.76	30

TYPICAL MISSIONS for Foresters I and II

or nations interested in space projects are expected to want to put more than one payload into orbit. The Cubic Corp. suggests 10 launches as an appropriate number over which to amortize the cost of each launch. This means that a 10-shot program will cost about $7 million, while any lesser number will be considerably more on a unit basis because of higher proportionate costs of tracking and command equipment, launch facilities and flight testing.

In a cost breakdown furnished by Cubic Corp., the company quotes $577,000 as the total needed to launch a *Forester I* as part of a 10-vehicle program. Expendable items would cost $380,000, as follows: guidance and control, $40,000; attitude control, $75,000; propulsion units, $185,000; accessory hardware, assembly, checkout and shipping, $80,000.

Amortized items: flight test program, $100,000; ground support (launch facilities), $20,000; tracking and command equipment, $77,000.

In a similar costing for *Forester II*, total amortized price per launch is $707,000. Expendable items, totaling $490,000: guidance and control, $40,000; attitude control, $100,000; propulsion units, $235,000; accessory hardware, assembly, checkout and shipping, $115,000.

Amortized items: flight test program, $120,000; ground support, $20,000; tracking and command equipment, $77,000.

- **How to cut costs**—*Forester* vehicles are radio-guided until third-stage separation. Fourth-stage spin-up is subsequently initiated, keeping the vehicle oriented for a coast period of about 400 seconds, followed by fourth-stage ignition and satellite injection.

At a recent space flight symposium in Tokyo, Charles J. Breitwieser, Cubic Corp. executive vice president, said the factor contributing most to the economy and efficiency of *Forester* is the integration of the tracking, range safety, guidance, and orbit determination and monitoring into a single problem area.

The radio guidance is provided by a tracking configuration consisting of a three-antenna interferometer field to give precise angular rates, in conjunction with range, range rate, and angle-measuring equipment.

The main guidance and control equipment on board are a modest autopilot, transponder and command receiver, in addition to a reaction control system actuated by the autopilot The autopilot is the on-board reference and is commanded by the ground system by means of the command receiver

Because a transponder and autopilo substitute for an airborne inertial guidance platform, Breitwieser estimates a saving of $70,000 per missile for otherwise expended hardware.

He also pointed out that one big advantage of the *Forester* tracking con figuration is the emphasis placed on measuring precision rates for the real time operation, a less costly undertaking than position measurements.

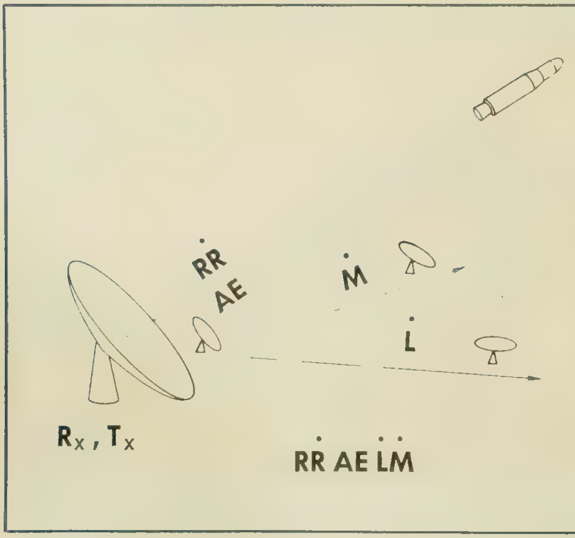
In addition, Breitwieser estimates that by using CW tracking equipmen over precision tracking radars will give a ground-installation savings of approximately $850,000. The main equipmen for the *Forester* tracking array is ex pected to cost approximately $500,000 versus $1.35 million for the conven tional precision tracking radar, according to his figures.

Besides tracking *Forester* vehicles the equipment can be used to track any vehicle carrying the transponder. Th computer facility, an integral part o *Forester,* is available equally as a tracking and telemetry data and scientific problem processing center when not in volved in vehicle checkout and launch

- **Electronics on hand**—"Al ground-based electronic equipments ar 'off-the-shelf'," claims the Cubic Corp The interferometer is a standard Cubi Corp. angle-measuring device with a baseline lengthened to give precis angular rates rather than the customar direction cosines, according to the com pany.

The distance-measuring equipmen (DME) is described as an FM/FM co herent modulation ranging channel. Th ranging equipment is a single standar Cubic Corp. DME station modified t include coherent carrier for range-rat measurements. Angle information fo the real-time operation is derived from 30-ft. directional antenna, duplexed t act as receiver/transmitter.

The measured observations said t be possible with the tracking array ir clude: slant range *R;* range rate *dR/d* azimuth angle *A;* elevation angle *E;* an the two direction cosine rates *dL/dt* an *dM/dt.* By processing these observation through a computer, Cubic expects para metric values for guidance, impact pr diction, tracking and orbit determin tion.



GROUND ARRAY for command, telemetry and tracking of Foresters I and II

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Exothermic Process Promises Brazing Applications in Space

Development is simpler, more economical than solar energy conversion systems; ignition to solidification time is quick

by John F. Judge

SAN DIEGO, CALIF.—Structures destined for assembly in orbit may be preprogrammed for remote-controlled joining operations—reducing the problem of equipment transportation and human manipulation.

The route to such a novel space fabrication means may be through an exothermic brazing process under active investigation here at Narmco Research and Development division of Telecomputing Corp.

The procedure involves packing the braze alloy and some exothermic tape material into selected areas in the joint. When the structure has reached its expanded or operational condition, the exotherm mixture is ignited, brazing the joint solid.

The ideal vacuum-joining process has three major characteristics:

—It requires little equipment other than that dictated by the structure itself. Equipment might be used that will become part of the structure.

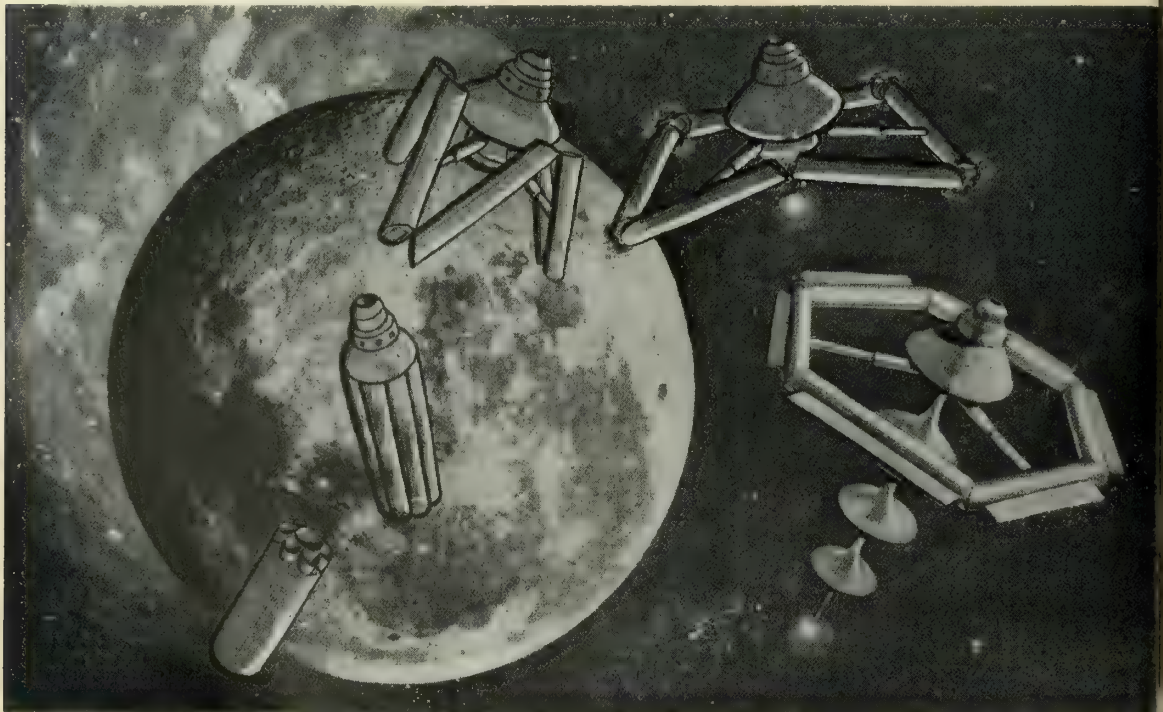
—It must be operable from stored energy sources such as solar batteries, storage batteries, and similar units.

—The result must be a reliable an reproducible bond.

• **Packaged heat**—Narmco's exothermic bonding techniques are extremely economical and simple whe compared to heating systems that depend on solar energy conversion.

All of the latter—with the exceptio of the direct use of the Sun's radiatio focused on the work area—involve conversion of solar energy to electricity an the associated storage and conversio of this electrical energy to heat.

Narmco experts have not made comprehensive analysis of the weight



ARTIST'S CONCEPTION of an expandable space station that could use exothermic brazing.

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Jack Faulkner speaks with authority on stress-relieved aluminum forgings

This man can help you
make forgings behave during machining

ALCOA

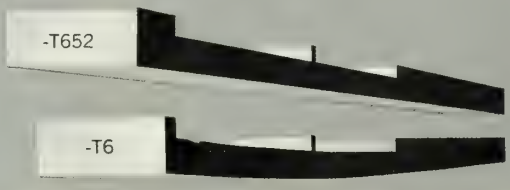
ALCOA PROCESSES FOR LOW RESIDUAL STRESSES IN FORGED PRODUCTS

PROCESS	TEMPER. DESIG. (1)	ALLOY	PRODUCT (3)	"TYPICAL" REDUCTION FROM -T6 (1)		
				WARPAGE	STRENGTH (4)	STATUS
STRESS RELIEF (2)						
MECHANICAL DEFORMATION (STRETCHING)	-T651	ALL	HAND FORGINGS (5)	95% (6)	ZERO EXCEPT LONGITUDINAL CYS 5%	COMMERCIAL
MECHANICAL DEFORMATION (COMPRESSING)	-T652	ALL	HAND FORGINGS (5) DIE FORGINGS (7)	90% (6)	ZERO EXCEPT TRANSVERSE TYS 5%	COMMERCIAL

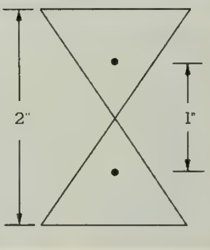
NOTES: (1) The use of the -T6 version of various tempers is for convenience only. The -T4 or -W temper is also available. (2) Processing is performed after heat treat and quench. (3) Products comprise hand forgings (including rings), die forgings and machined parts. (4) Guaranteed values available on specific part inquiry. (5) Except parts tapered in thickness or otherwise impractical to process. (6) Based on observations by users; these values representative but subject to variation with geometry and machining details. (7) Subject to geometry of individual part; deformation may be all stretching, all compressing or a combination. Some parts cannot be effectively stress-relieved by this technique—see context.

Jack Faulkner
speaks
with authority
on stress-relieved
aluminum
forgings

Alcoa has recently instituted an identification system which provides positive evidence of proper compressive reduction. Prior to cold working, forgings are bench-marked with a special 1- or 2-in. gage length stamp. Measurement after working of the reduced distance between the punch points indicates the amount of compression obtained, thus permitting positive control within the specified range.



This photograph shows the warpage difference after machining in two pieces of a large hand forging (5 x 11½ x 140 in.); the -T6 piece bowed over 2½ in. compared to a little over ⅛ in. in the stress-relieved -T652.



Residual stress built up during quenching of aluminum forgings can cause trouble later when the forgings are machined. Machining unbalances these stresses. When a tool bites into a non-stress-relieved forging, it tends to warp, even jump out of the fixture or jig.

Little was known about stress relief until 1944, when Alcoa's Kirby Thornton first explained the principle of *stretching*. This method is still used on extrusions, plate and rolled shapes.

Stretching, however, proved impractical for some geometrical shapes—die and hand forgings and rolled or forged rings. But *compression* was found to relieve stresses just as stretching did!

Jack Faulkner, who heads the Military Equipment Section of Alcoa's Cleveland Development Division, was one of the pioneers in working with stress relief by "squeezing." Today Jack offers Alcoa's customers years of experience in the complexities of this technique.

TIGHT TOLERANCES, MINIMUM WARPAGE—Compression stress-relieving makes hand and die forgings behave during subsequent machining operations. For instance, Alcoa recently made a hand forging in the form of a 90° arc of a 30-ft circle, with a cross section of 6 by 8 in. The customer had to do extensive machining, and assembly requirements called for a maximum departure from flatness and contour of .030 in. over its length of some 20-odd ft. Maximum warpage experienced during machining was .005 to .010 in.

Jack Faulkner is just one of hundreds of Alcoa's technical experts whose principal function is to help customers with metallurgical and fabricating problems. These "development men" are experienced engineers who have not only specialized in aluminum, but in specific industries. Jack, for instance, has worked almost exclusively with customers in the aerospace and military equipment industries for sixteen years. Have a problem that might involve aluminum? Just call your local Alcoa sales office. Or write Aluminum Company of America, 1872-J Alcoa Building, Pittsburgh 19, Pa.

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ALCOA

power output of various solar energy-conversion techniques. But the simplicity of the exothermic process and its adaptability to vacuum environments point to applications in joining space structures.

Controlled exothermic compositions with heat outputs of 400 to 1,400 calories/gram have been used by Narmco to provide heat for the joining of stainless steel, super alloys and titanium alloys. Exothermic compositions capable of providing up to 300 calories/gram are theoretically possible.

The heating concept under investigation at Narmco provides a rapid heat pulse to a base metal and a braze alloy —reaching the processing temperature while minimizing base metal and braze alloy corrosion and structural changes in the base metal.

The concept has been in research at Narmco for more than five years under both corporate and government sponsorship. The Air Force is currently funding the development program.

Narmco engineers list several anticipated design advantages in on-site space structure fabrication. These include:

- **Short heating times**—Time from ignition to braze alloy solidification is about 5 to 45 seconds, depending on section thickness and insulation effects. The time above the critical temperature—the initiation point of re-crystallization, grain growth or solution of precipitated phases—is only a small fraction of the total time.

Structural changes from these critical temperatures effects will be minimal during the imposed thermal cycle.

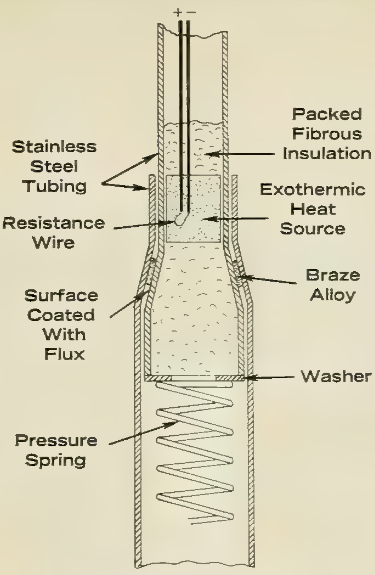
—*Transient liquid phase*—The base metal interactions will be at a minimum because of the short time period. Thus a braze alloy having higher melting temperatures and strength can be used.

—*Remote control*—Exotherm ignition can be accomplished automatically through use of trip switches and/or telemetered energy. These ignition designs can be pre-packaged.

—*Module bonding*—Bonding units can be made independent of auxiliary power sources—providing a reduction in lift-off weight. Of equal importance, say Narmco specialists, automatic exothermic bonding could be used in functions of a space vehicle where it is impractical to include other power equipment. A potential application here is extension and making aerodynamic surfaces rigid for glide-re-entry vehicles.

—*Portability*—The lightweight brazed joint designs are inherently portable, and making field attachments and repairs under primitive conditions may be possible.

- **Vacuum effects**—Narmco has evolved two groups of exothermic systems—those that will not ignite in a vacuum and a smaller group that will. The reason for non-ignition of most of the systems is perplexing to Narmco researchers since the reaction is self-contained.



TELESCOPING SPACE STRUCTURE ELEMENT

In addition to the possibility of atmospheric oxygen aiding any ignition performed in air, the researchers have tabulated three possible reasons for the occurrence.

—Removal of gaseous products from the reaction interface before reaction in which the oxide is reduced to oxygen and/or a lower oxide by heat, and any gaseous oxygen is removed by the pumping effect of the vacuum before it can combine with the reducing portion of the system.

—The reactant surface area-volume ratio may be critical, so that a reaction capable of occurring in air will not do so in a vacuum. An adjustment of this ratio may be all that is necessary.

—The small quantities of gas occluded within the particles of the system components may be released by the initial reaction. This sudden release could result in increased partial pressure in this immediate area. This could disperse the hot particles, preventing propagations.

Narmco researchers feel that non-ignition is complex and would probably be a combination of the above and other phenomena At reduced pressures, the reaction may be inhibited by all the postulated events—making the combination of metals and oxides more critical. A more active metal may be required to reduce any given oxide in a vacuum than would be necessary in air.

An effort is under way to determine the causes of non-ignition along the major suppositions outlined above. The route is through a proper understanding of the reasons for non-ignition.

A literature survey is being conducted to determine the various space structure designs being considered for possible use. Various movable and rigidized joint designs to be considered are: hinge joint, ball and socket joint, lap joint, miter joint, saddle-shaped joint and sliding joint. ■

Exothermic System Selection Explained

THE 22 EXOTHERMIC systems in the table (p. 54) were chosen by Narmco on the basis of theoretical heats of formation as those being most promising for vacuum joining. The first 12 of these systems had been used in previous experiments.

The pertinent characteristics of these systems were measured at Earth ambient conditions. Those systems in which ignition temperature, maximum temperature, burning rate, theoretical heat of formation, calorimetric heat and reaction product compatibility with the selected base alloys were favorable, had their selected characteristics remeasured in a vacuum on the order of 10^{-6} mm Hg. These include systems 205, 207, 3, 116, 104, 210, 11, 13, 14, 17, 22 and 205 reduced particle size.

Systems 1, 105, 104, 209 and 112 were eliminated on the basis of their low heat output. System 2 was eliminated because of the corrosive effect of its reaction products on the base metal and relative ignition insensitivity (hard to ignite by hot-wire technique). Systems 11, 14, and 222 were eliminated when the reaction could not be sustained.

Systems 205, 207, 2, 210, 17 and 221 were eliminated because they would not ignite in vacuums of 2 x 10^{-6} mm Hg. Systems 203, 27, 28 and 223 have not been investigated sufficiently to justify a decision. Systems 116, 13 and 22 ignited at pressures of 2 x 10^{-6} mm Hg. These latter three were the only basic systems ignited at low pressures,

(continued on p. 54)

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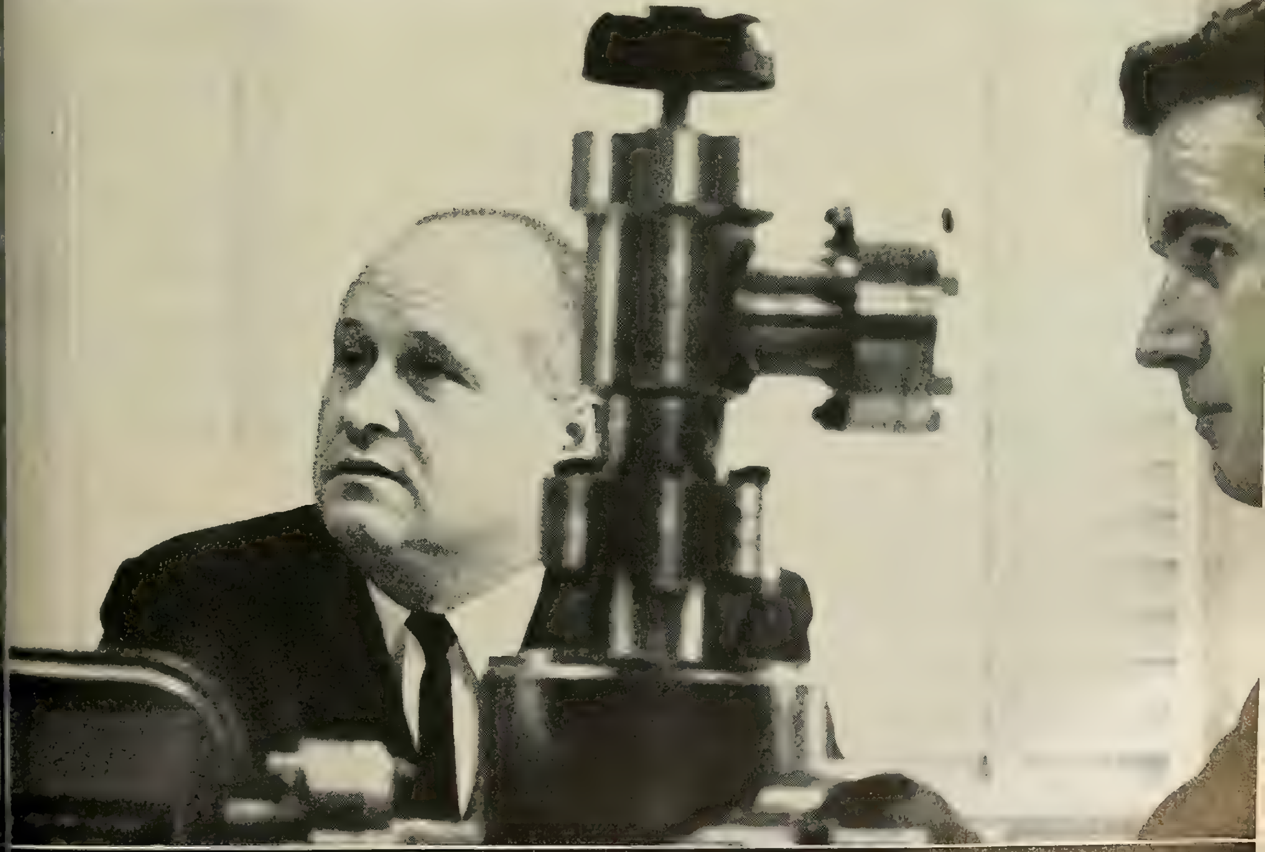

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Exothermic Systems

(continued from p. 51)

but many of the other systems can be combined with these ignitable systems to improve certain charactertistics.

Experiments to determine the effect of vacuum on heat transfer has indicated that little change is to be expected over that obtained in air, but the reduced pressure does result in a decrease in exotherm heat-producing and/or heat transfer efficiency over that at ambient pressure.

A search for data relative to the vapor pressures or rates of evaporation of the components of these exothermic systems is being conducted. Data collected indicate that the materials in the exotherm systems will be only slightly effected by reducing pressure.

At temperatures above 1,800° F. however, and at pressures of 2×10^{-6} mm of Hg, significant evaporation rates may be obtained. Since the rate of evaporation increase that results from reducing the pressure from 2×10^{-6} mm Hg to 2×10^{-9} mm Hg. is negligible, a vacuum of 2×10^{-6} mm Hg is adequate for this investigation.

Preliminary investigations as to the effects of power particle sizes were carried out at both atmospheric and reduced pressures. The particle sizes of the components of System 205 were reduced and the effect of this reduction examined. It gave a burning rate of 2.53 sec/in. to 0.25 sec/in., but had no discernible effect upon the other characteristics measured. ■

PROPERTIES OF EXOTHERMIC SYSTEMS

System	Ignition Temp. °F	High Temp. Thru Panel °F	Calorimetric Measurement Cal/gram	Theoretical Heats of Form. Cal/gram	Effect on Base Metal	Burning Rate Seconds/Inch
203 $15Mg+77Cu_2O+8SnO$	979	1697	--	605	--	083
205 $25Mg+52NiO+23MnO$	1059	2449	627	757	--	2.53
1 $12Al+78Cu_2O+10SnO_2$	1722	--	--	478	-	--
2 $20Al+56NiO+24MnO$	1722	2324	--	698	Damage	--
104 $27(Na_2O.SiO_2)+8SiO_2$ $+6B+59CuO$	875	1329	815	500	little	--
105 $7Borax+18SiO_2+7B+68NiO$	1101	1177	--	816	--	--
207 $29Mg+46NiO+25MnO_2$	993	2397	509	1010	--	.25
3 $23Al+50NiO+27MnO_2$	1432	1771	1790	947	--	.016
116 $16B+84V_2O_5$	925	2003	1722	591	Erosive	.78
209 $16Mg+57Ag_2O+28CuO$	990	1114	-	716	--	Violent
210 $24Mg+47Cu_2O+29MnO_2$	1150	2469	256	880	-	066
112 $8Borax+8B+84CuO$	949	883	-	843	Erosive	.08
11 $74Cr_2O_3+26Al$	1482	22,297	1267	633	--	No propagation
13 $86WO_2+14Al$	1640	2279	365	414	--	.093
14 $83Ta_2O_5+17Al$	1488	2405	20	326	--	No propagation
17 $33Al+67V_2O_5$	1019	2500+	1349	1086	--	.033
22 $27Al+73MoO_3$	1130	2204	812	1098	--	.016
221 $40Mg+60V_2O_5$	978	1922	--	1136	--	<.016
27 $83CrF_2+17Al$	1274	1733	520	304	--	4.73
28 $80VF_3+20Al$	1100	1589	1265	648	--	2.5
222 $27CrF_2+73Mg$	1846	--	2056	3006	--	--
223 $75VF_3+25Mg$	844	1684	1135	851	--	.016

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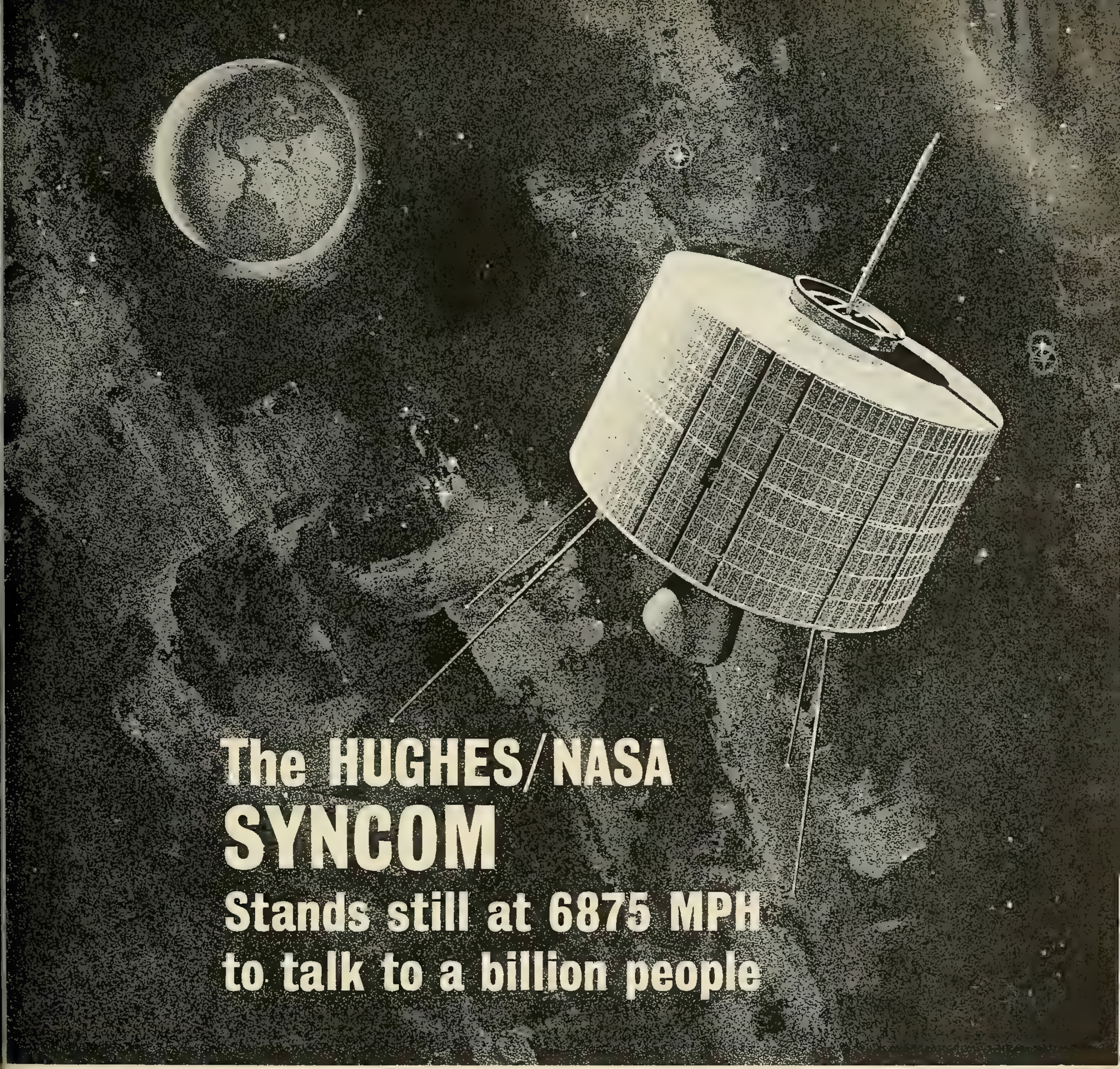

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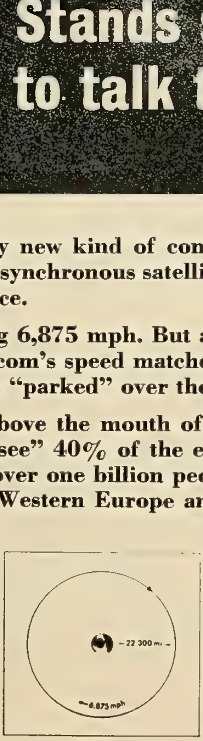

◀ *Syncom differs* from other satellites in that it is precisely controlled in a high-altitude orbit. Here it can be permanently "parked," while other types of satellites are in random, low-altitude orbits.

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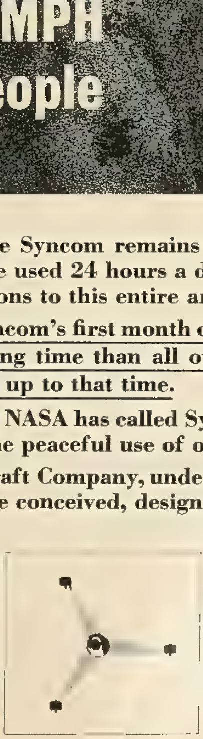

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Pilot Control of Rendezvous Stressed

Consensus at symposium is that thrust capacity should be boosted as soon as possible to enable fuel wastage; a report on advances

by Rex Pay

EDWARDS AFB, CALIF.—Pilots of spacecraft should control space rendezvous and docking, and the sooner propulsion systems are developed to make this possible, the better.

This was the most widely expressed opinion at the Space Rendezvous, Rescue and Recovery Symposium held here recently.

Improvements in simulation techniques have shown that when a pilot is given realistic visual cues he becomes increasingly successful at flying rendezvous missions.

At present, the limited thrust capabilities of U.S. vehicles make it necessary to optimize trajectories so that rendezvous can be achieved with minimum fuel expenditure. And the requirements for accuracy accompanying such procedures tend to emphasize automatic rendezvous systems. Much of the discussion at the symposium centered on this approach.

But the consensus was that as soon as some margin of fuel wastage is allowable—even 5%—the accuracy requirements drop, and the task comes within the scope of the pilot.

• **"Real systems" demanded**—The pressing need for an ability to perform missions that do not involve optimization to conserve fuel was underlined by P. G. Felleman of MIT Instrumentation Laboratory.

Felleman said that what was required was the ability to rendezvous with an orbiting vehicle, friendly or unfriendly, at any time, irrespective of time or weather at the launching pad.

In fact, an optimum trajectory for fuel conservation might be far from optimum for the tactical requirements of a mission.

"I think we've heard enough about optimum-impulse co-planar orbit transfers," said Felleman. "This problem has been solved. We have heard enough of derivations of linearized equations of relative motion. This problem has also been solved.

"We need a breakthrough. We have to start looking at the hard problems. We have to design real systems."

Such systems will use large boosters, to give the necessary fuel margins for departure from "optimum" trajectories. And as such boosters become operational, the shift in emphasis away from fuel optimization will mean that a sizeable obstacle to manual control of rendezvous will have been removed.

• **Future automatic needs**—A qualification to this view was added by C. A. Lysdael of Space-General Corp. He said that while man could play a significant part in simple guidance situations, more difficult situations would justify the use of advanced automatic guidance and control systems to achieve minimum expenditure of fuel.

"Saving a few feet per second can buy a whole lot of guidance and control equipment," said Lysdale.

He noted that nothing was said at the symposium about pursuit and evasive guidance systems—for uncooperative rendezvous or for the avoidance of rendezvous. He felt this was an important subject.

Also absent at the symposium was any discussion of advanced guidance and control systems. These would certainly be required in sophisticated pursuit and evasion situations.

Omission of these topics played a large part in restricting discussion of unmanned rendezvous.

• **Soviet pressure**—The importance of manned rendezvous was further stressed in a luncheon speech by Avco's Dr. Arthur Kantrowitz, who predicted that a Soviet permanent manned space station would be put into orbit within a year or two. He foresaw that this space laboratory would come up with concepts that could have decisive effects on our strategic deterrent.

Commenting later on Kantrowitz's speech, Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, said "I did not note any difference from my own views in what Dr. Kantrowitz said. . . ." He added that in past months NASA and DOD had been doing more thinking than previously on the use to which space stations could be put.

NASA has a number of research studies out on manned space stations and DOD recently issued requests for proposals on similar studies.

• **Second-phase navigation**—Rendezvous with a space station or some other orbiting vehicle usually is split into two phases. The first involves a transfer maneuver and may take place when the two vehicles are thousands of miles apart. The second starts at a separation of some 100,000 ft. and finishes with the docking operation.

D.C. Born, Douglas Aircraft Company, referred to the second phase as "micro-rendezvous" and suggested that manual control of this phase is receiving considerable attention because a pilot's vision, judgment and flexibility of response can reduce system complexity and improve mission reliability.

However, he felt that at the beginning of this second phase, navigation data sensors and descriptive data displays would be needed. For an on-off propulsion system, he suggested a display involving five meters, which would have to be augmented with additional meters because of the three-dimensional nature of the rendezvous problem.

The pilot's capabilities were also emphasized by R. L. Stapleford, Systems Technology Inc., who suggested that many proposed systems were not making full use of man's capabilities as a pilot. "I would like to see more emphasis on the use of man's capabilities and on the use of simple aids to improve his capabilities, before we go to brute force techniques like computers," said Stapleford. He had in mind simple aids such as visual range-finders.

• **Optics help**—A new optical aid that goes part way towards meeting Stapleford's requirement of simplicity was described by F. E. Baird of the Boeing Company. He said the device could detect targets with angular motions as low as 0.1 milliradian per second against a random star background. Detection of small sunlit targets at ranges of 100 mi. should be possible, he added.

The device consists of a telescope mounted on an inertial platform that stabilizes the field of view of the telescope so that the stars appear as fixed points, in spite of the telescope's motion.

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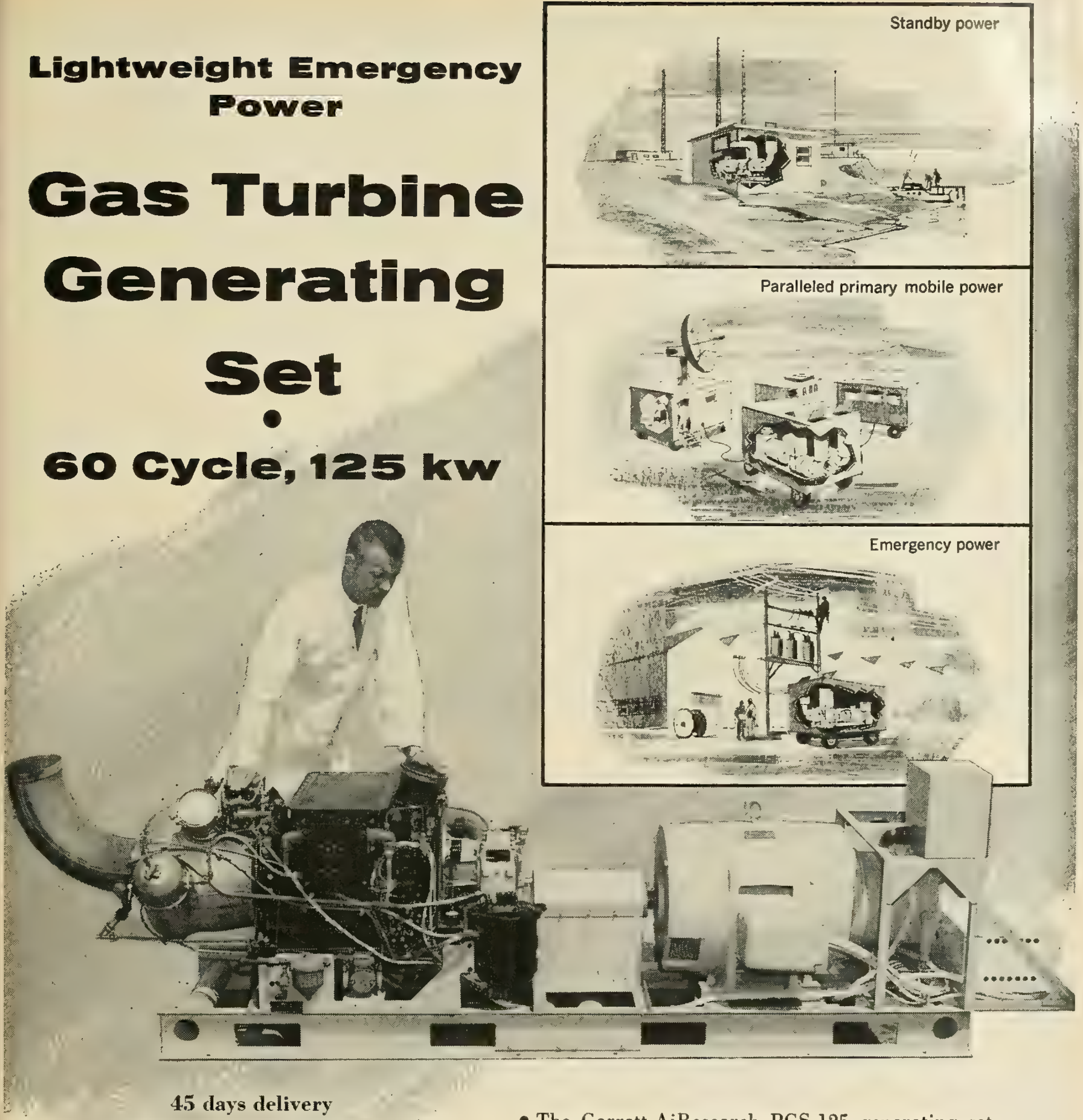

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moving across the background of fixed stars. Detection of the satellite then depends on detection of its movement. This is achieved with the aid of a linear reticule inserted into the telescope. The parallel lines of opaque material that make up the reticule periodically interrupt the light from the moving satellite, producing a blinking image. This contrasts strongly with the steady star images.

In simulator experiments, the target satellite was detected five times as fast when using an 833 line/in. reticule than when viewing without a reticule.

The need for an optical sensor that would enable the detection of very low angular rates was stated by J. R. Burton of McDonnell Aircraft Corp. Referring to the optical back-up system for *Gemini* rendezvous, he said that "our particular problem comes about because we don't have a lot of acceleration capability and, of course, we don't have a lot of fuel to expend. And while we are at the long ranges of rendezvous collision courses the angular rates are so low that we just don't find devices that will sense them. Consequently we end up discovering too late that we should have done something five minutes ago."

● **Three choices**—Three techniques will be available to the *Gemini* astronauts for their rendezvous maneuver with an *Agena-D* rocket. These are a visual system, a combination of visual guidance with information from an active-radar system, and a closed-loop system. The all-visual system relies on ground tracking and commands for execution of the mid-course maneuver and is aided by two flashing lights installed on the *Agena*. In the closed-loop system, the radar data and information from an inertial measuring unit are processed by a digital computer to yield guidance commands.

The launching restrictions for rendezvous are quite severe. There is a 1.8-hr. window during which the *Gemini* spacecraft can be launched into the correct plane. In this window there are one or two 16-min. intervals when the launch will put the *Gemini* in the correct phase relationship with the target *Agena*.

However, the maneuvering capabilities of the *Agena* are such that its orbit can be adjusted from the ground to extend the launch window to about four hours. The *Agena* can also be maneuvered by commands from *Gemini*.

The main rendezvous maneuver will be carried out over three-quarters of an orbit. This gives more efficient fuel utilization than a quarter-orbit rendezvous, which was also considered.

A spring and shock-mounted docking cone on the *Agena* will enable the initial rendezvous and docking to be

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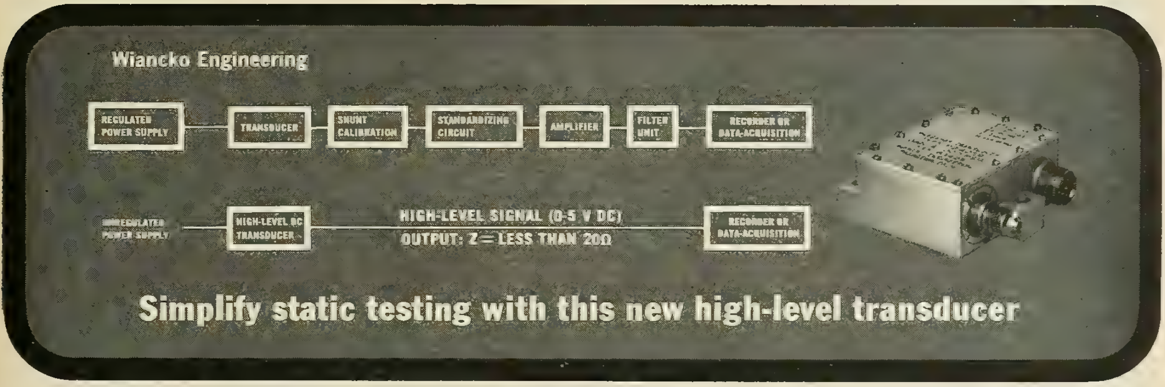
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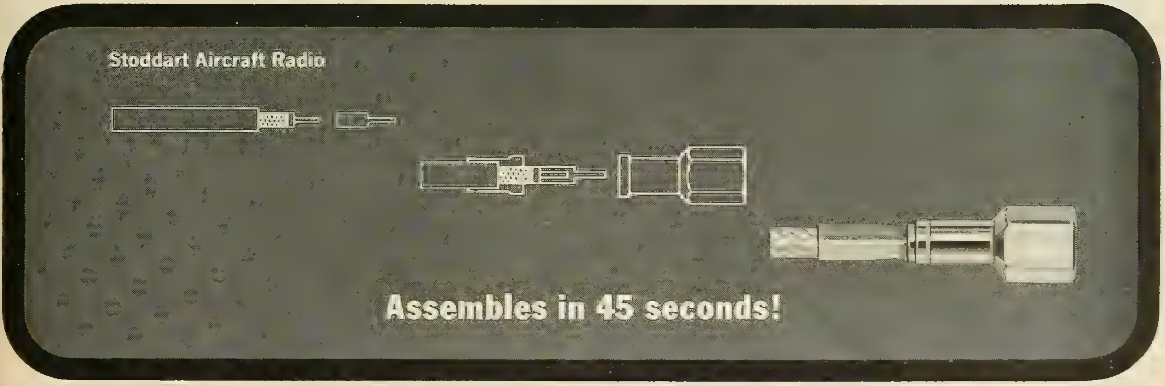
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followed by a series of practice dockings for in-flight astronaut training.

A doubling up of maneuvering capabilities similar to the *Gemini* mission will also be a feature of the *Apollo* mission. In this, both the Lunar Excursion Module (LEM) and the Lunar Service Module will be capable of completing the lunar orbital rendezvous. Again, optical aids and rendezvous radar will be installed, as well as inertial guidance equipment and a digital computer.

- **Ability demonstrated**—A number of simulator experiments confirming a pilot's ability to carry out the final stages of rendezvous and docking manually were reported.

A. C. Little of General Electric Company described the manned docking simulator with five degrees of freedom that has been built at the company's Missile and Space Division. Mounted in a gimbal system, the simulator floats on four air bearings.

Initial tests show that the simulator is easily controlled by simple on-off reaction jets and three-axis stick controllers. Typical acceleration levels in the system are 4°/sec.^{2} yaw, and 0.9ft./sec.^{2} forward and backward. GE found that experienced pilots have no difficulty in executing the docking maneuver.

On completion of the present test series, a four-man crew, living 30 days in a simulated space station cabin, will be required to guide an unmanned resupply ferry (the simulator) through a rendezvous and docking maneuver.

A moving base simulator with six degrees of freedom has been constructed at the Boeing Company. It operates over closure distances of 80 ft.

Results of tests with a number of pilots show that they can control docking with a high degree of success and that little, if any, instrument aid is required.

A field of view of 32 deg. laterally by 16 deg. vertically was not found to be restrictive. When this viewing area was reduced by a third, pilots still were able to complete docking without using any extra fuel.

The pilots preferred three-axis control of thrust. They also preferred low acceleration levels, but these used most fuel. Rate modes of attitude control were consistently preferred to manual direct mode.

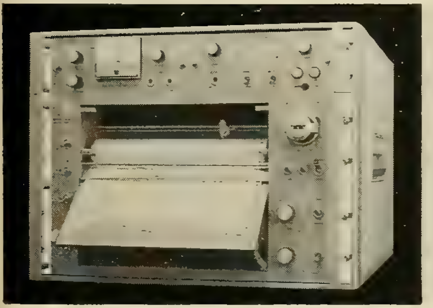
Experience with this simulator and other programs where reaction control has been studied for vehicle control has led Boeing to conclude that handling-quality criteria for docking can be expressed as a function of space-vehicle angular and linear accelerations. Angular accelerations between 0.5 and 2.5/sec.^{2} and linear accelerations between 0.08 and 0.4 ft./sec.^{2} are considered satisfactory by Boeing. The company says a much wider, but yet to be defined, range of accelerations would be acceptable.

- **Last word**—The ultimate in manual rendezvous was discussed by D. P. Novak. AFIT, Wright-Patterson AFB, Ohio. He described a method whereby a man could travel about a mile in space from one orbiting satellite to another, with only his pressure suit, a small self-maneuvering unit, and his sense of vision. With this indispensible minimum he has only the stars to guide him.

The technique found most suitable, by theoretical investigation, is the fixed-line-of-sight maneuver. As the astronaut steps out of the interceptor, he will see an apparent drift of the star background. He then gives himself a slight impulse in the direction of the target and at the same time nulls the apparent drift of the stars by applying a force in a direction perpendicular to a fixed line between himself, the target, and a distant star.

The fuel consumption involved in this technique approaches that of the ideal two-impulse maneuver for short rendezvous times.

The technique, however, can be used only when the target and the star background are visible. That is, the astronaut must reach the target before it intercepts Earth's horizon. ■



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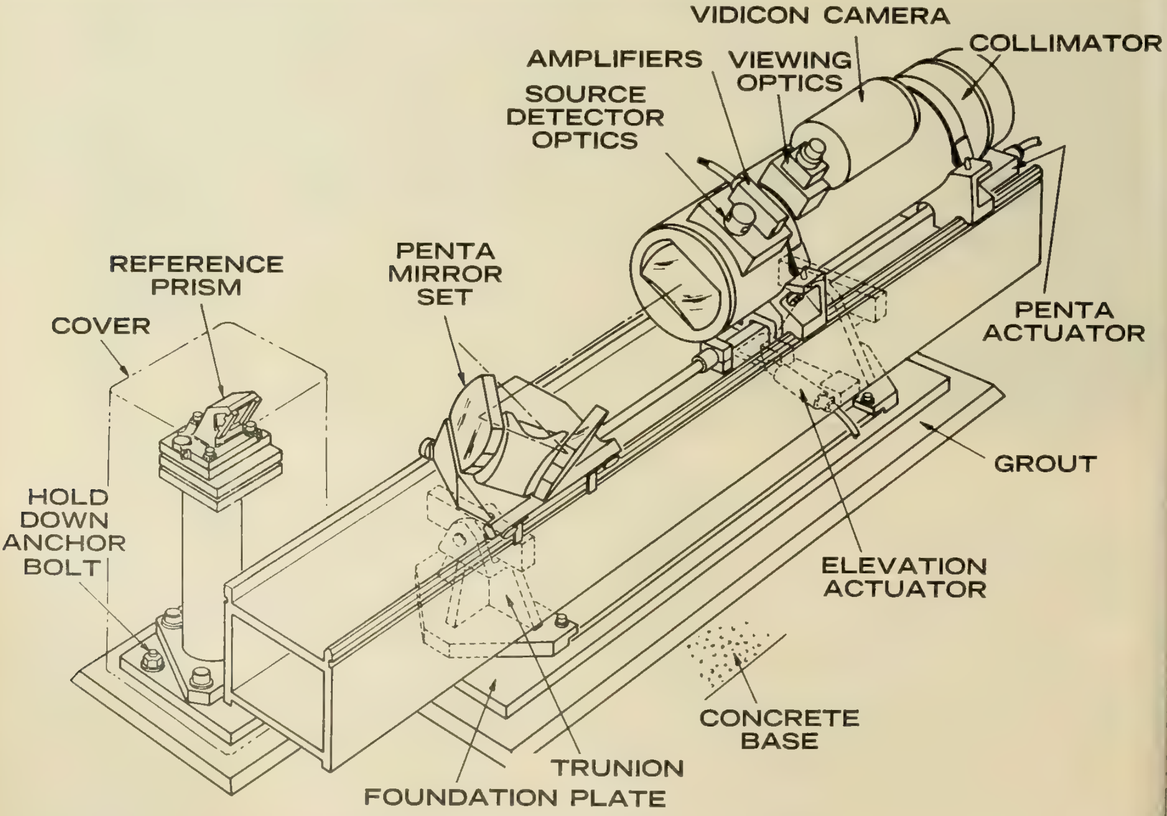
Perkin-Elmer Theodolite System For Saturn Tested at Cape Canaveral

by Michael Getler

AZIMUTH ALIGNMENT of *Saturn* booster guidance systems, made just prior to launch at Cape Canaveral, will soon benefit from the introduction of a new and highly accurate alignment theodolite system with accuracies reported to be "closely approaching theoretical optical limits."

Three of the new theodolites have been built for NASA's Marshall Space Flight Center under a $250,000 contract by the Perkin-Elmer Corp.'s Electro-Optical Div., developers of the system.

The system, according to the firm, is capable of operating at distances of 300 to 1,000 ft., at elevation angles of 20 to 40 degrees, and with accuracies at these long distances of about 2 to 3 arc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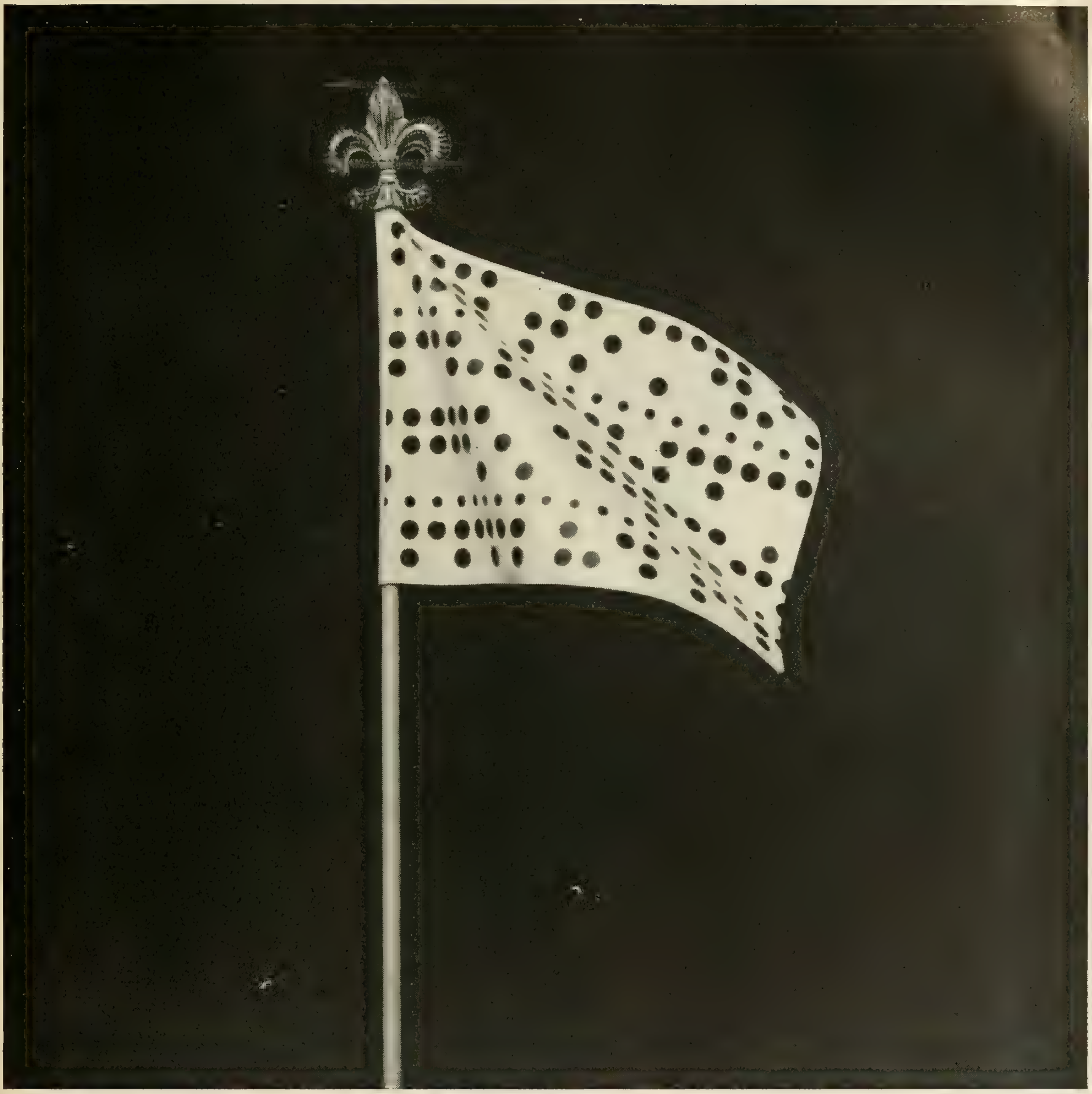
CONCRETE BASE
TRUNION
FOUNDATION PLATE

LINE DRAWING of basic Saturn theodolite shows key portions of system located at ground site.



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System tested down to one arc sec . . .

secs. This corresponds roughly to azimuth system alignment accuracies of 1/1,000 of a compass degree. Original specifications on the device called for 5-second (1/720 degree) accuracy.

The accuracies can be maintained, according to P-E, through the unique system design, even in the presence of ±3 in. of dynamic vehicle sway and ±12 in. of long-term deflection.

Vehicle sway can be caused by several influences including wind, gantry movement, or flexure and shrinkage associated with fuel weight and cryogenic effects.

- **Tests at AMR**—P-E engineers told M/R that in tests with the device at AMR, "shooting at a guidance platform about where the *Saturn V* will sit, we saw accuracies of 2 arc secs. In the lab," they report, "with no air shimmer, and at short ranges, we have been down to 1 arc sec."

Although the system reportedly can operate at 1,000 ft., the actual distances involved in *Saturn V* alignments are more likely to be about 700 ft.

Essentially, the P-E system consists of a defraction-limited theodolite operating in conjunction with a small 2-in. by 2-in. prism set within the launch vehicle's inertial guidance system. P-E originally built three of these single-prism systems, but modifications are now underway to add a second prism to the device and extend the sway-tracking capability over twice the original range. There are also changes aimed at automating the sway-track capability, improving on the semi-automatic operation of the earlier system.

The first dual-prism system was delivered to AMR late in August. A second unit will be delivered to the Cape, with the third going to Marshall Space Flight Center. Though both P-E and NASA express great expectations for the system, the theodolite is expected to get a thorough run-through in an open-loop situation on upcoming *Saturn* launchings before it assumes azimuth alignment duty.

According to P-E, the basic theodolite consists of an 8-in.-aperture automatic null-sensing autocollimator whose line-of-sight is directed through a moveable translating penta mirror set (see diagram), which deviates the beam to the *Saturn* inertial platform prism(s). The reflected energy detected in the autocollimator generates an error signal when the vehicle moves from the desired azimuth orientation. A NASA-supplied television hook-up, working through the autocollimator, keeps the vehicle constantly in view.

Initial positioning and sway compensation adjustments are made in accordance with the TV view. A second TV system will also provide remote viewing; controls, operated through direct-current relays, permit parallel remote operation.

- **System description**—Heart of the P-E system is the autocollimator, which consist of an 8-in. off-axis Maksutov catadioptric lens of about 30-in. focal length with associated automatic, TV, and visual sensing means at its focus.

Within the instrument, P-E engineers report, light from an incandescen lamp is made alternately incident on either side of a slit-sensing prism by a motor-driven chopper. The light is reflected to the objective lens, collimated and transmitted to the *Saturn* platform prism though an optical window in th *Saturn* vehicle skin. The reflected energy is transmitted to the objective len which re-images the illuminated slit i its own plane at unity magnification.

According to the firm, if the plat

(Continued on page 66

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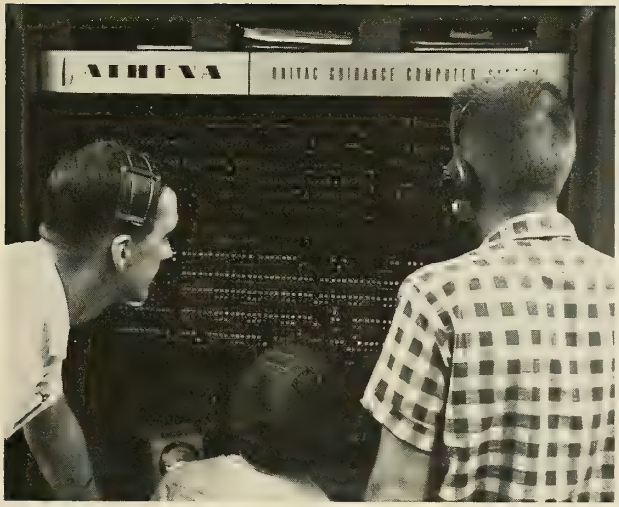

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form prism is not precisely normal to the autocollimator axis, the returned image will be laterally displaced on the slit, and light will be incident on a lead sulfide detector located just behind the slit, thereby indicating an azimuth error. The magnitude of the signal is proportional to the prism deviation from null, and the signal phase indicates the direction of deviation. Chopping phase is sensed by a detector that provides the reference signal required for error signal demodulation. Also, a separate acquisition detector is included to provide a positive acquisition signal very near the null position.

The linear width of the slit is 0.005 in., which corresponds to an autocollimator proportional measuring range, at distances of 1,000 ft., of ±17 arc secs.

The 8-in. aperture autocollimator is capable of accommodating a ±3-in. launch vehicle dynamic sway. Long-term deflection of ±12 in. or greater uses the moveable penta mirror to bring the theodolite back into proper alignment.

The penta mirror, according to P-E, is a constant-deviation device that permits translating the transmitted beam precisely parallel to itself even in the presence of small penta angular disturbances. Penta angular motion of more than 4 arc minutes must occur before the transmitted beam will shift more than 1 sec. The penta is moved down a track about 30 in. long by a ball-bearing lead-screw actuator driven by a dc motor.

In the early system, the penta was directed by toggle switch operation based on TV view. In the modified system, automatic tracking has been accomplished by adding another detector in the viewing optics to drive a servo motor.

At the end of prism travel (see diagram) is a rigidly mounted reference prism aligned with its apex horizontal and oriented normal to the desired azimuth direction of the *Saturn* platform prism alignment. The reference prism is used to check autocollimator null alignment.

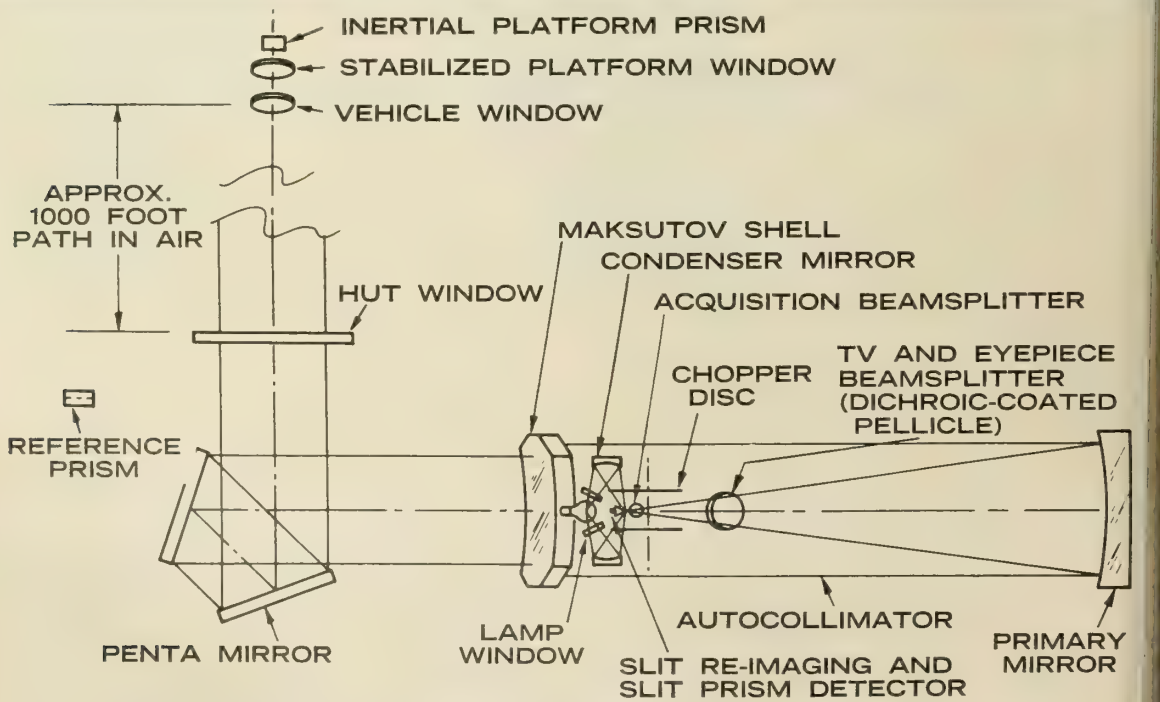
- **Alignment concept**—The theodolite alignment concept described by P-E first involves installation, leveling, and rough alignment of the basic theodolite and reference prism. The autocollimator is energized, and, with the penta in the center of its travel, it is adjusted in azimuth and elevation until the viewing system is centered on the launch vehicle prism window.

The penta is then moved in front of the reference prism and the latter is adjusted in azimuth until the autocollimator is nulled. By means of a first-order survey, the azimuth of the reference prism, and therefore of the alignment direction, is then determined.

The entire system will be installed in a separate air-conditioned hut, with the theodolite mounted on a stainless steel bed which, in turn, is installed on a stabilized concrete base.

P-E engineers stress that the associated TV links and system connections enable the entire operational procedure to be monitored or performed from the blockhouse area.

The theodolite's ability to work at all wavelengths, in effect, led to the dual-prism capability that has recently been added to the system. Engineers state that they now are able to monitor two inertial platform prisms simultaneously using just one theodolite by color-coating the prisms so that the spectrum is divided, and different wavelength response is achieved. Accuracy of each



DRAWING OF COMPLETE theodolite-launch vehicle relationship depicts launch site setup in simplified fashion.

New power for space will come from America's first liquid-hydrogen engine, the RL-10. This upper-stage powerplant is being developed by Pratt & Whitney Aircraft for NASA's Marshall Space Flight Center. The RL-10 is designed to stop and start in deep space, with advanced models offering throttle control of power. Pratt & Whitney Aircraft provides design and manufacturing leadership in power for many applications, in and out of this world.

Pratt &
Whitney
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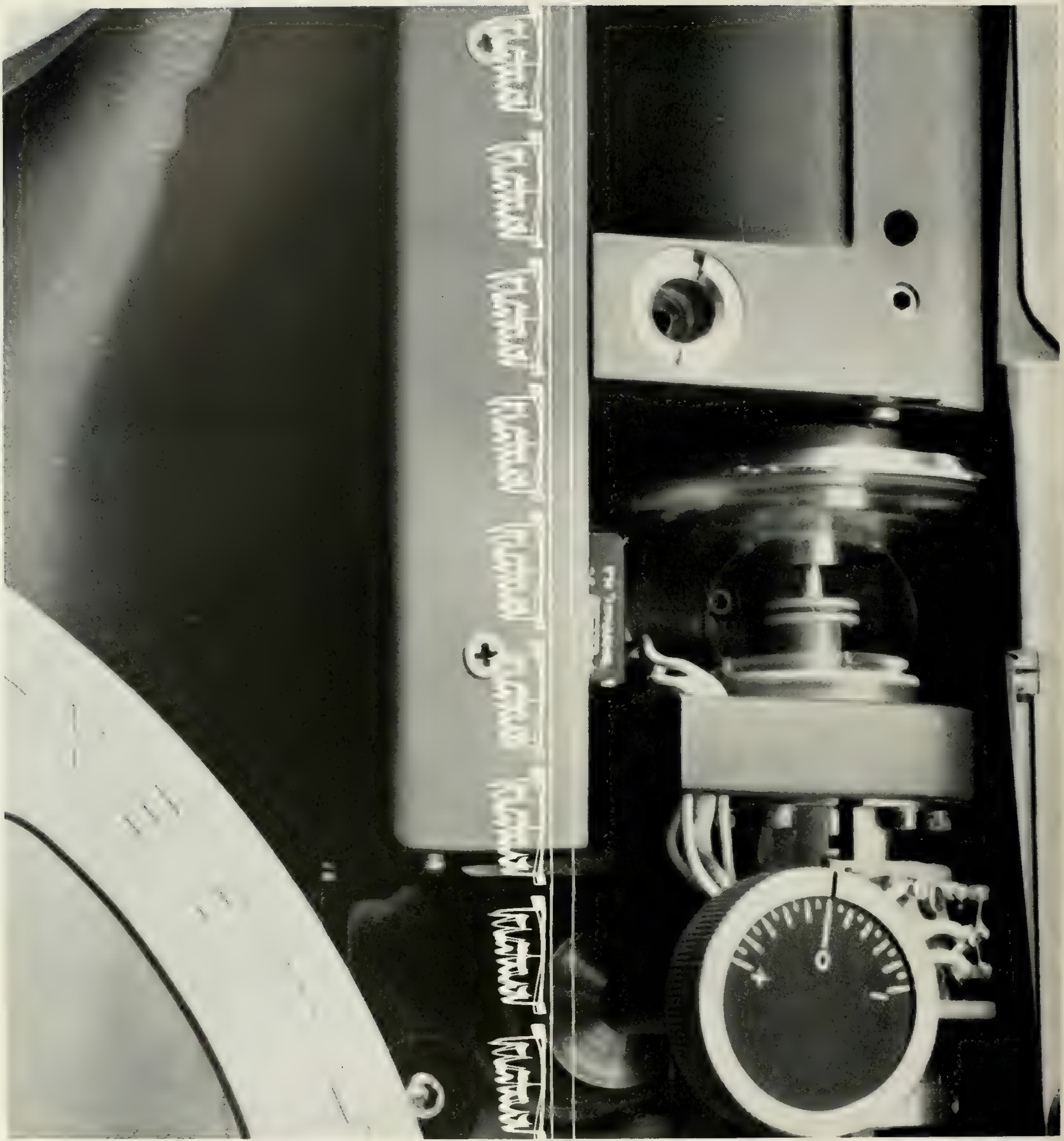

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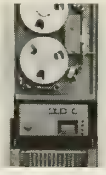


AMPEX

Circle No. 2 on Subscriber Service Card

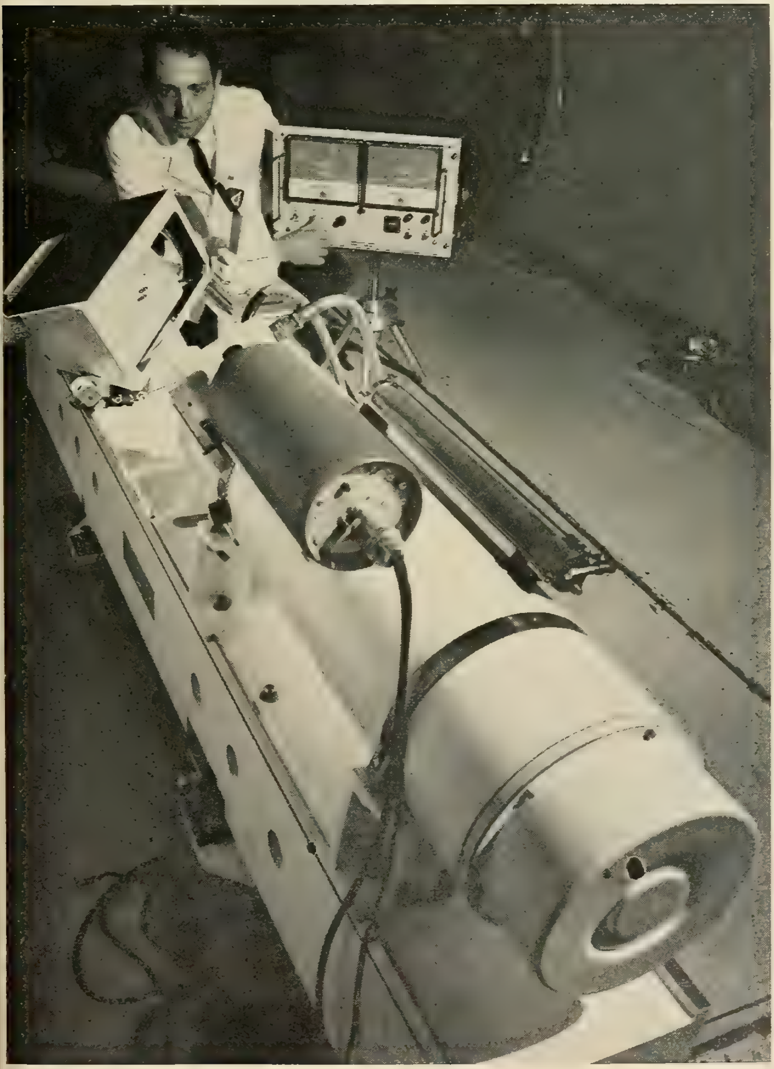
Second prism adds accuracy . . .

channel in a two-channel system is also said to be about 3 arc secs.

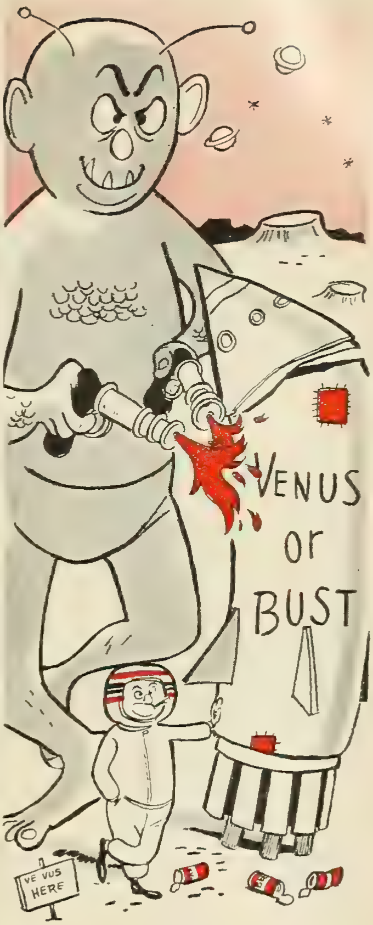
Essentially, NASA reports, the addition of a second prism to the system allows the *Saturn* guidance system to move more accurately to a mission azimuth, by insuring, on the ground, that the zero position of the inertial frame is accurate to the required tolerances. Before the addition of this second channel, NASA says confidence could be undermined by certain inaccuracies connected with associated ground support equipment and lengthy cable links between the vehicle and alignment gear.

In the dual-prism design, both electro-optical servo-loops are active initially in establishing a zero reference, and then a single loop actively maintains the baseline reference azimuth on the stabilized platform while the launch control computer programs the inertial frame to the desired firing azimuth.

Most of the changes required in the dual-prism system were made in the detector section of the autocollimator, including addition of about three more sets of detectors. The electronics associated with the system had to be doubled. ■



PERKIN-ELMER CORP. engineer runs checks on unit in firm's Norwalk, Conn., laboratory. System is reported to be capable of accuracies of 2-3 arc secs. over ranges up to 1,000 ft. It approaches the theoretical optical limits.



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Our care packages go to space-people.

And that's only the first leg of the journey: to the people at NASA/Huntsville and Chrysler Corp., prime contractor on the Saturn S1 Booster.

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We have also tooled and manufactured lightweight waffle-skin cylinders for other NASA projects. And dozens of tooling and test fixtures for future Saturn vehicles.

We handle every NASA job with speed, as well as care. Tasks that should have taken weeks have been delivered in days. We've produced some over weekends. Even turned out a few overnight. And all of them to tight specifications.

When the call comes for fast work we can respond with the most sophisticated production machinery available anywhere. Supported by technicians and engineers who thrive on rush-and-hustle.

And NASA knows it.

Which is one reason why, when the countdown for the moon begins, some of Republic's packages will be on the pad.

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A reminder: your CARE packages help the needy abroad. Send a check to CARE, New York, today.

Mergers and Acquisitions

Garrett Corp. officials have filed a complaint in United States District Court to restrain Curtiss-Wright in its efforts to purchase 700,000 shares of Garrett stock. Garrett bases its case on the Clayton Anti-Trust Act, which prohibits a company from acquiring stock in another if such an acquisition restrains competition. . . . *Space Technology Laboratories, Inc., formerly a subsidiary of Thompson Ramo Woolridge, Inc., Redondo Beach, Calif., has been merged with the parent organization. Now to be known as TRW Space Technology Laboratories, the organization will operate as a division of TRW, Inc. The change was made to assure maximum efficiency and utilization of the parent firm's capabilities and facilities.* . . . International Telephone and Telegraph Corp., New York City, is purchasing the assets of Gilfillan Corp., Los Angeles, producers of ground and shipboard radar. The acquisition of the four-plant firm will move ITT into a new area of industry. . . . *The name and assets of American Measurement & Control Div. of CompuDyne Corp., Burlington, Mass., has been purchased by D. G. O'Brien, Inc., Natick, Mass. AM&C, manufacturers of electrohydraulic and electromechanical devices and servosystem components, will operate as a division of O'Brien. O'Brien produces pressure-proof electrical connectors and other electrical equipment.* . . . Lundy Electronics and Systems, Inc., Glen Head, N.Y., has acquired the McMillan International Corp., Ipswich, Mass., a research firm specializing in multi-core absorbers, Aperiodic filters and mica-coated products. Lundy also gains exclusive license arrangements for microwave radiation absorbers and wave-absorbing dielectric walls, plus the right to acquire all stock of McMillan Industrial Corp. and McMillan Laboratory, Inc., producers of radomes, absorbers and free space rooms. . . . *Elcor, Inc., Falls Church, Va., formerly a subsidiary of Welex Electronics Corp., Washington, D.C., has been made a division of the Welex firm. The reorganization was made to support expanding activities of the company. Elcor will continue to manufacture isolated power supplies, transformers and current measurement instruments, while lending technical support to R&D programs for Welex.*

New Firms and Divisions

Polara Corp., an electronic components firm, has been formed at Farmingdale, N.Y., for the design and manufacture of precision slidewire potentiometers. Engineering and manufacturing facilities have been set up in an 8,000-sq.-ft. plant. . . . *Associated Metal Industries has been formed in Cambridge, Md. The firm will manufacture wire mesh slings for missile/space and industrial use.* . . . Bart Manufacturing Corp., Newark, N.J., has established a microwave division to design, produce and market flanged, electrically-tested waveguides and assemblies. The division, known as Bart Microwave, will also offer antenna reflectors, maser and laser reflector devices and similar precision components.

Facilities

Mansol Ceramics Co., Belleville, N.J., has doubled production capacity with an addition of 15,000 sq. ft. of manufacturing space. The firm produces special glasses and preforms for the hermetic sealing industry. Mansol is a subsidiary of Faradyne Electronics Corp. . . . *Winston Research Corp., a subsidiary of Fairchild Camera and Instrument Corp., has moved to a 20,000-sq.-ft. plant in Los Angeles. Winston manufactures wideband instrumentation recording systems, video transmitting and receiving equipment and display systems for military, missile/space and industrial applications.* . . . The Franklin Institute Laboratories, Philadelphia, has organized a new laboratory in industrial engineering. Joel N. Bloom has been named manager. The lab will be part of the Operations Research Div. Research will be concentrated in the areas of information and control systems, job performance research and economic analysis. . . . *The atomic, defense and space group of Westinghouse Electric Corp., Pittsburgh, has established a Rocky Mountain district with headquarters in Albuquerque, N.M.* . . . Milgo Electronic Corp., Miami, Fla., has opened its Eastern Regional Sales and Service Office in Washington, D.C. The office will market and service Milgo's range instrumentation, data handling and computational systems in the area.

International

Kaiser Aluminum and Chemical Corp., Oakland, Calif., has joined with two Japanese firms to form the Sky Aluminum Co., Ltd. The firm will build and operate an aluminum sheet and plate rolling facility in Japan. Construction of the plant will begin late this year with completion expected by the end of 1965.

Potpourri

Dyna-Search Control, Inc., a computerized technical recruiting service center, has been formed in Minneapolis. Dyna-Search uses a Control Data Corp. computer system to record, store and evaluate applicants' qualifications and a Bell Telephone-built tele-typewriter to exchange information with client companies. Knowledge patterns of applicants contained in the computer system can be analyzed and compared at the rate of 500 per minute. . . . *The Department of Defense has begun action to recover $230,000 that it regards as an excess charge for the lease of computer systems by the Martin-Marietta Corp., Orlando, Fla. DOD said the Government could have saved the amount by having Martin purchase the equipment under its cost-reimbursible defense contract instead of leasing it. Martin officials defended their action as "reasonable in the light of the circumstances."*

missiles and rocket

Advanced Research, Technology and Development

Issue Date
November 25
1963

Advertising Closes
November 11
1963

Projects Gemini and Apollo are well under way. The National Aeronautics and Space Administration is currently planning future projects like the orbiting space station, lunar base, manned Mars expedition, unmanned exploration of the Sun and the distant planets, and detailed investigation of Earth's environment.

M/R's Third Annual National Aeronautics and Space Administration issue will be a 100-page report covering advanced research, technology and development requirements for these programs.

hird annual NASA issue

This issue will include:

1. Advanced Research and Technology

Spacecraft Structures ☐ Propulsion ☐ Nuclear Systems ☐ Electronics ☐ Biotechnology and Environmental Systems

2. Funding Requirements and Procurement Policy

NASA's in-house apportionment of the Fiscal Year 1964 Budget ☐ Effects of Congressional cuts in the budget ☐ Report on Fiscal Year 1965 Budget ☐ Budget Projection through 1975

3. Advanced Development Programs

Manned Spaceflight ☐ Unmanned Interplanetary Spacecraft ☐ Scientific Satellites ☐ Commercial Application Satellites ☐ Launch Vehicles after Saturn ☐ International Programs

4. NASA Field Centers

New facilities and equipment required at each installation by the advanced spacecraft and launch vehicles.

5. Directory of Key NASA Officials

Name ☐ Job Title ☐ Room and Telephone Numbers

5,000 Bonus Circulation to NASA Officials

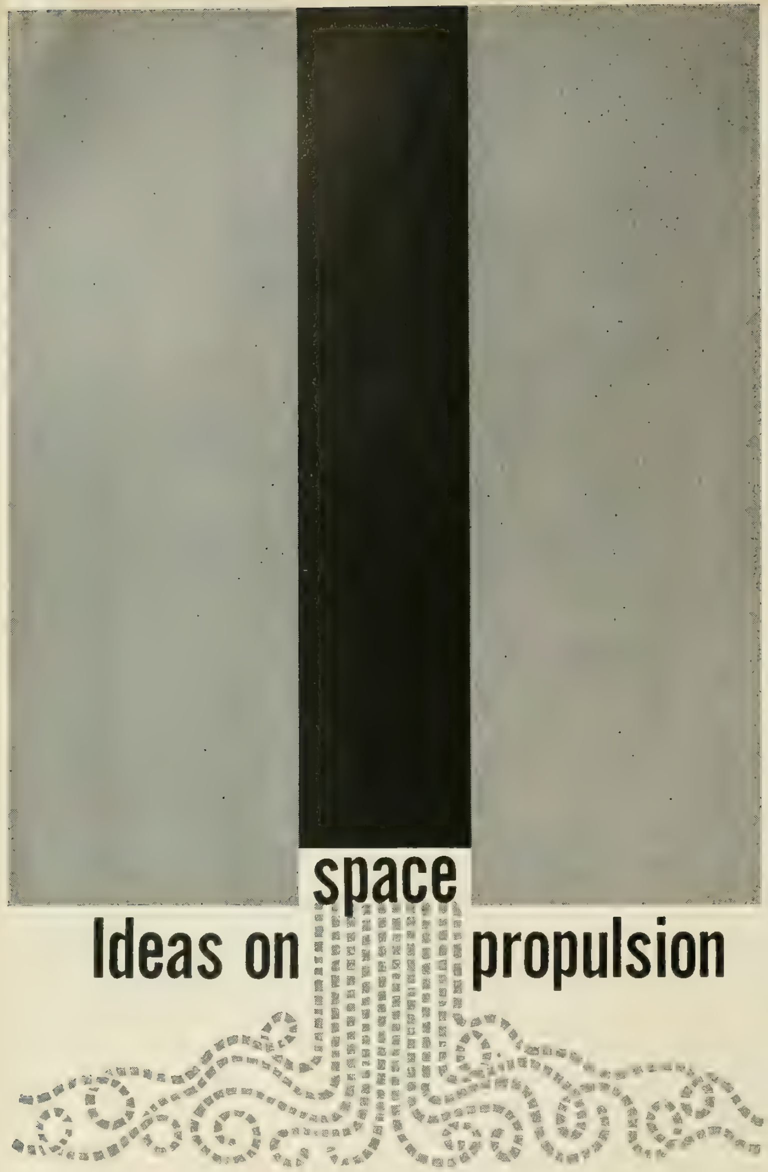
Total NASA Circulation 6,500.

43,170 Regular ABC paid circulation.

48,170 Total Effective Audience

NASA will award many of the study and hardware development contracts for these projects by mid-1964. Advertise your products and capabilities in M/R's Third Annual NASA issue to reach your audience at this critical decision time.

Advertising Closes [illegible]



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Circle No. 26 on Subscriber Service Card

contracts and procurements

AWARDS

AIR FORCE

$3,800,000—**Space General Corp.**, El Monte, Calif., for production of telemetric communications equipment on the Atlantic Missile Range.

$3,200,000—**Union Carbide Corp.**, New York City, for research and development of uniform, reproducible carbon-base materials to meet high-temperature requirements in advanced aerospace systems; development of new or improved manufacturing methods for the production of large-scale pieces of high-strength, uniform and reproducible graphite for use on large rocket motors; obtain comprehensive design criteria for CFW grade graphite in large sizes; research on unconventional methods of processing unique graphite materials, and research on high-temperature, oxidation-resistant protective coatings for graphite (five contracts).

$2,500,000—**Geotechnical Corp.**, Garland, Tex., for work on a classified project.

$1,800,000—**General Electric Co.**, Syracuse, N.Y., for conversion of radar sets.

$1,800,000—**Tumpane Co.**, Marietta, Ga., for operation and maintenance of AFSC's Space Systems Div. facilities at Los Angeles.

$1,600,000—**Bendix Field Engineering Co.**, Owings Mills, Md., for radar equipment upgrading.

$874,866—**Lear Siegler, Inc., Instrument Div.**, Grand Rapids, Mich., for steel vertical gyroscopes.

$695,476—**Martin Marietta Corp.**, Baltimore, for storage and distribution of the TM-76 *Mace* missile.

$258,060—**Polystructures, Inc.**, Stoneham, Mass., for construction of a rigid radome.

$118,000—**Whirlpool Corp.**, Benton Harbor, Mich., for development of devices to recover potable water by thermoelectric distillation and vacuum distillation, the investigation of the effects of oxygen exposure on freeze-dried foods, and development of a prototype thermoelectric flight feeder for a combat aircraft (four contracts).

$100,000—**Thompson Ramo Wooldridge, Inc., Tapco Group**, Cleveland, for redesign of a 120-inch nozzle for the big solid booster program.

$34,194—**Varian Associates**, Palo Alto, Calif., for modification of *GAR-11* fuze, using klystron, with Q-10 testing.

ARMY

$2,300,000—**Bendix Corp., Friez Instrument Div.**, Baltimore, for electronic equipment.

$2,000,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for advanced production engineering of *Shillelagh* missile subsystems.

$2,000,000—**Northrop Corp., Nortronics Div.**, Anaheim, Calif., for *Hawk* missile wing assemblies.

$520,520—**McCulloch Corp.**, Los Angeles, for engines for target missiles.

$435,000—**Textron's Bell Aerosystems Co.,** Buffalo, N.Y., for operation and maintenance of a data-reduction center for the Electronic Proving Grounds, Ft. Huachuca, Ariz.

$430,000—**Westinghouse Astronuclear Laboratory,** Pittsburgh, for conceptual design of the basic power systems needed in support of NASA's manned lunar base proposal.

$377,978—**Graham Contracting, Inc.,** Orlando, Fla., for construction of a missile radar station at Merritt Island, Fla.

$314,615—**Sperry Rand Corp., Sperry Utah Co.,** Salt Lake City, Utah, for repair parts for the *Sergeant* missile (four contracts).

$223,860—**Babcock Electronics Corp.,** Costa Mesa, Calif., for target missile airborne transmitters and receivers.

$202,072—**Hanson Brothers, Inc.,** Whittier, Calif., for modification of GFP rocket motor containers and GFP rocket guidance containers.

$189,587—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for studies and evaluations of the *Shillelagh* missile system.

$93,364—**Radio Corp. of America, Service Co. Div.,** Camden, N.J., for technical and engineering services related to guided missile programs.

$79,940—**General Dynamics Corp., Pomona, Calif., Div.,** for *Mauler/Redeye* missile familiarization courses.

$33,025—**General Electric Co., Defense Electronic Div.,** Syracuse, N.Y., for a high-power acquisition radar.

$28,500—**Ryan Aeronautical Co.,** San Diego, Calif., for repair parts for the *Q-2* or *124E* target missile.

Burns & Roe, Inc., New York City, for design of a new propulsion facility for test and equipment checkout of the system being designed for the Lunar Excursion Module. Equipment will be installed at the White Sands Missile Range (undisclosed amount).

International Telephone and Telegraph Corp., New York City, for production and installation of an electronics "pod" in one of the Army's ITT-built transportable ground stations for Project Trade Post (undisclosed amount).

Electro-Mechanical Research, Inc., College Park, Md., for a detailed study of radiation tolerant voltage controlled oscillators (undisclosed amount).

NAVY

$10,700,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for engineering and logistic services on the *Polaris* missile program.

$1,000,000—**Scope, Inc.,** Falls Church, Va., for seven electronics countermeasure sets for adaption to shipboard use.

$285,000—**Ling-Temco-Vought's Temco Display Systems Plant,** Garland, Tex., for production and installation of a tactical-navigations display system aboard the U.S.S. Wasp.

$99,675—**Bjorksten Research Laboratories,** Madison, Wis., for a continuation of research and development efforts on high-viscosity refractory thermal protection materials for use in rocket and missile systems.

$75,000—**Cubic Corp.,** San Diego, Calif., for improvements to the COTAR tracking system at Pt. Mugu, Calif.

$49,948—**Scientific-Atlanta, Inc.,** Atlanta, for a satellite-tracking antenna pedestal.

$30,720—**American Concertone, Inc.,** Culver City, Calif., for a magnetic tape recorder.

NASA

$300,000—**Systems Engineering Laboratories, Inc.,** Fort Lauderdale, Fla., for digital data equipment, which includes a digital tape writing station, a telemetry ground digitizing system, and a telemetry data analysis system and servicing of the units.

$252,000—**General Electric Co., Spacecraft Div.,** Valley Forge, Pa., for development of the operating procedures for the *Nimbus* technical control center at the Goddard Space Flight Center, plus personnel training of engineers and technicians who will operate the center.

$165,000—**Radio Corp. of America, Electron Tube and Semiconductor Div.,** Mountain Top, Pa., for provision of solar cell modules for *Nimbus* satellites and the *Nimbus* operational system.

$144,036—**United Aircraft Corp.,** East Hartford, Conn., for a study of the non-equilibrium flow effects in high-expansion ratio nozzles.

$136,046—**Ling-Temco-Vought, Inc.,** Dallas, for a training program for Italian space commission personnel.

$130,000—**Martin Co.'s Denver Div.,** Denver, for a study of the effects of ground winds on *Saturn* boosters while in the vertical launch position.

$100,000—**Naval School of Aviation Medicine,** Pensacola, Fla., for a biosatellite experiment covering pathophysiological efforts of weightlessness on primates, with primary attention to vestibular organs.

$99,974—**G. T. Schjeldahl Co.,** Northfield, Minn., for fabrication of 15 prototype micrometeoroid sensors.

$99,859—**Applied Research Laboratories, Inc.,** Glendale, Calif., for a spectrometer.

$91,666—**Avco Corp.,** Tulsa, Okla., for pulse-counting detectors.

$91,412—**Stanford Research Institute,** Menlo Park, Calif., for a tactual sensing system.

$63,900—**Byron Motion Pictures, Inc.,** Washington, D.C., for operation of a NASA central motion picture depository.

$53,997—**Control Data Corp.,** Minneapolis, for computer equipment leasing.

$48,203—**University of Oregon Medical School,** Portland, for an ocular impedance plethopmograph.

$45,000—**Ling-Temco-Vought's Temco Display Systems Plant,** Garland, Tex., for production and installation of an Iconorama display in NASA's *Nimbus/Tiros* Control Center, Greenbelt, Md.

$32,204—**American Brake Shoe Co., Dynisco Div.,** Cambridge, Mass., for pressure transducers.

$30,922—**Union Carbide Corp.,** Chicago, for liquid nitrogen.

$30,181—**Beckman Instruments, Inc.,** Fullerton, Calif., for design, development and delivery of a prototype PH measuring system.

$28,364—**North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for a biosatellite experiment involving the study of tissue regeneration and wound-healing while in a weightless state.

International Telephone and Telegraph Corp., Federal Laboratories Div., Nutley, N.J., for provision of a spaceborne communications solid-state transmitter for the *Nimbus* metsat program (undisclosed amount).

INDUSTRY

$1,200,000—**Moog Servocontrols, Inc.,** East Aurora, N.Y., from **North American Aviation, Inc.,** for manufacture of steering controls for the *Minuteman* missile.

$300,000—**Mobile Rentals Corp.,** Los Angeles, from the **Boeing Co.,** for transportable office space for the *Minuteman* missile program.

$209,000—**Thiokol Chemical Corp., Shawnee Operations,** Shawnee, Okla., from **North American Aviation, Inc.,** for development and building a large three-axis flight simulator for testing of *Apollo* spacecraft control systems.

Electro-Mechanical Research, Inc., College Park, Md., from the **Sandia Corp.,** for development of telemetry subsystems consisting of subcarrier oscillators, low level amplifiers, voltage regulator, commutator and calibrator (undisclosed amount).

SCM Corp., New York City, from **Sperry Rand's Univac Div.,** for high-speed electronic data printers (undisclosed amount).

Computer Sciences Corp., Houston, from **Milgo Electronic Corp.,** for radar control of a large missile tracking system at White Sands, N.M. (undisclosed amount).

Electronic Specialty Co., Los Angeles, from **McDonnell Aircraft Co.,** for automatic checkout equipment for classified electronic reconnaissance systems and a government-sponsored antenna study in high-gain arrays for reconnaissance applications.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Purchasing Office
Range Procurement Div.
(MTDRC-1)
Air Force Missile Test Center
Patrick Air Force Base, Fla.

Frequency control and analysis (FCA) spectrum surveillance system in accordance with technical exhibit SE/3531-1248, spare parts, instruction books, drawings and other support items. Delivery to Patrick AFB, Fla.—1 system. This procurement will be accomplished in two phases: 1) Submission and evaluation of the technical proposals without pricing to determine acceptability of supplies and services offered. 2) After evaluation of firms having technically acceptable proposals, IFB will be issued only to those firms having technically acceptable proposals. Letter request for technical proposal 64-1072Q. TP due date 10-21-63. Complete data unavailable. Available specs, plans or drawings relating to the procurement described above do not fully provide all necessary manufacturing and construction details.

Contracting Officer
Naval Weapons Laboratory
Dahlgren, Va.

Research and development services to provide for computer programming and analysis, system design, documentation and associated services required in connection with the development of the automatic digital system for space surveillance. A contract is in the process of being awarded to System Development Corp., 2500 Colorado Ave., Santa Monica, Calif., therefore, other proposals will not be considered for this procurement. Firms interested in subcontracting opportunities should contact the above firm.

Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

Negotiations to be conducted with United Aircraft Corp., Corporate System Center, Farmington, Conn., for continuation of research on the stellar inertial guidance concept. RFP ASD-3003-WVA. For information only. No RFP available.

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Can you measure the change in current at Hoover Dam when a bulb blinks on in L.A.? Tell the thickness of cigarette smoke? Detect an air leak that would take 10,675 years to inflate a volleyball?

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Microminiaturization Specialist: Consult advanced engineering groups on use of integrated circuits and microminiaturization techniques for advanced radar, stellar guidance systems, and airborne computers.

Advanced Radar Specialist: Perform H-port studies involving stochastic processes, including the analysis of high frequency receivers and techniques for application to atmospheric and space radar systems.

Systems Specialist: Responsible for the integration of inertial components, digital computer equipment, stellar monitoring, and radar equipment into a complete guidance system.

If you are ready to move ahead with one of the nation's top electronics organizations, send your resume now to Mr. K. J. Romano, Professional Employment, 3370 East Anaheim Road, Anaheim, California.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

Autonetics
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Manning the frontiers of electronic progress

New Product of the Week:
Pulse Transformer

Sperry Electro Devices Laboratory has developed a pulse transformer designed to provide a high-voltage trigger for spark gap assemblies.

The device operates in a temperature range of —29 to 52°C and at altitudes up to 12,000 ft. It is insulated to handle peak transient voltages up to 400,000v. Both primary terminals are insulated to permit polarity reversal; the low voltage secondary terminal is insulated for 30 kv.

Electrical characteristics include: input voltage, 15,500v peak; pulse width, 1 microsec.; pulse repetition rate, 100 pulses/sec.; output voltage 200,000v peak; and turns ratio, 1:13.

Circle No. 225 on Subscriber Service Card

Subminiature Pentode

A sharp-cutoff, heater-cathode subminiature pentode is available from Raytheon Co.'s Industrial Components Div.

The eight-pin Model CK5636 is a dual-control tube packaged in a standard JEDEC (3-1) subminiature glass envelope. Tubes are manufactured to comply with MIL-E-1 specifications.

Circle No. 226 on Subscriber Service Card

Pendulous Accelerometer

A 100-g total-range pendulous accelerometer with high natural frequency has been developed by the Transducer Div. of Giannini Controls Corp.

The Model 24155 G provides a voltage-ratio output that varies in direct proportion to the g-values of acceleration in two directions. The ouput is obtained by using a spring-supported mass to actuate the noble metal brush of a precision, wire-wound potentioneter.

The 1-cu-in., 2.25-oz device has a natural frequency of 20 to 100 cps. Its 200-turn-minimum potentiometer provides a 0.5% resolution.

Range of the accelerometer is ±2 to ±50 g. It has a typical dynamic error band of ±3.0% under 50-g's range and ±2.0% over 50 g's. Linearity, repeatability and hysteresis are all a maximum of 1.0% full scale.

Circle No. 227 on Subscriber Service Card

Potting Resins

Dow Corning Corp. is marketing two silicone flexible resins that cure at room temperature, one transparent and the other opaque. The transparent product is called Sylgard 184. Sylgard 185 is the black, opaque resin.

Both cure in 24 hours at room temperature without exotherm after a curing agent is mixed with the resin. Curing time can be shortened by heating. Both products retain physical and electrical properties from —65 to 200°C and show little change in electrical characteristics over a wide range of frequencies.

Circle No. 228 on Subscriber Service Card

Evaporating/Melting Facility

Electron Heating Corp. is marketing an electron beam vacuum evaporator and melting facility.

The unit consists of two separate and interchangeable chambers with electron beam guns (one for melting and the other for evaporation); a high speed, high capacity pumping system; control system; and high voltage power supply.

The melting chamber has a 24-in. inner diameter and 30 in. high with a double wall construction for water cooling. The evaporation chamber has an 18-in. inner diameter and 20-in. outside height and is completely water jacketed.

The high-vacuum system features a pumping unit designed to handle large outgassing loads at operating pressures. Both chambers operate from the common pumping system.

Circle No. 229 on Subscriber Service Card

Crystal Microbalance

A compact, ultrasensitive instrument designed to measure evaporated films as thin as 10^{-8}g/sq. cm. is available from the Westinghouse Scientific Equipment Dept. The model 701 quartz-crystal microbalance measures changes in mass deposited on a crystal surface by measuring the corresponding change in resonant frequency of the crystal.

The instrument is able to measure directly the mass of films, either metal or dielectric, without correction for any other phyiscal properties over a range of 0.05 to 40,000 angstrom units with an accuracy of better than 1%. The instrument features an electrical readout which may be used to measure or control the process rate of deposition.

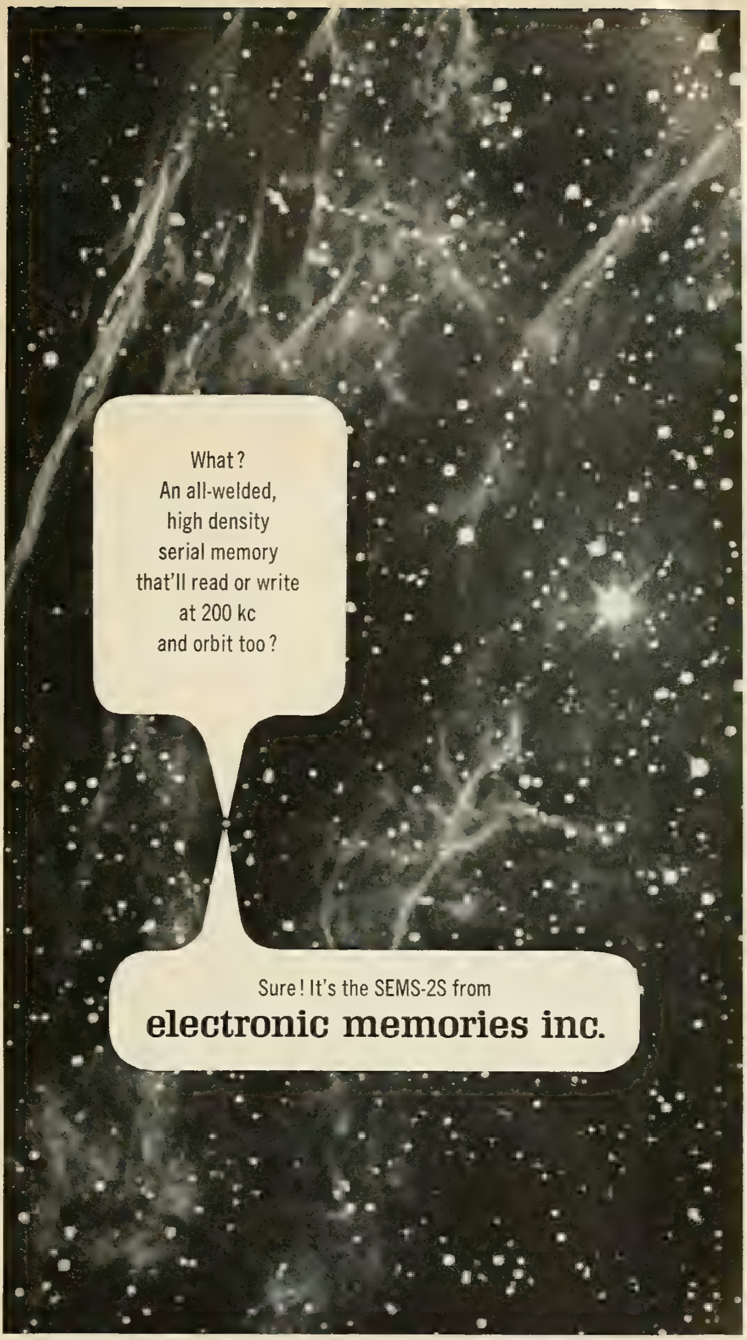
Circle No. 230 on Subscriber Service Card

Component Oven

The Electronics Div. of Hi-G, Inc., has available a thermoelectric component or crystal oven. The device is self contained, requiring only dc power for the Peltier module and ac for the solid-state proportional rate control circuitry.

The unit is factory-set at any prescribed temperature from 0 to 25°C and operates within an ambient temperature of —55 to 30°C. It automatically reverses current flow from heating to cooling action and is capable of maintaining prescribed temperature with ±0.5°C short term, and ±1.8°C long term. Rate of cooling is 15 minutes to 0°C at 25°C ambient. Maximum heat pumping capacity is 14 watts. Cavity volume is 1.7 cu. in.

Circle No. 231 on Subscriber Service Card



electronic memories inc.

SEMS-2S packs a lot of core memory performance into only 45 cubic inches. If you have a serial memory requirement, this new design could open a wide range of applications.

All component modules are welded for extreme ruggedness, reliability and low volume. Operating temperature range spans —55°C through +100°C because of Electronic Memories Isodrive* cores which maintain constant output over wide temperature excursions.

The SEMS-2S is available in a wide range of sizes, from 5005-bits through 150150-bits. May we send you our SEMS-2S brochure?

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DC Miniature Blower

Globe Industries, Inc., is marketing the type VAX-1.5-DC Blower which delivers up to 19 cfm of free air with a 50-v dc blower or 16 cfm of free air with a 27-v dc blower. The unit measures 1$\frac{9}{16}$ x 2 in. and weighs approximately 4.5 oz.

Designed to meet MIL-M-8609, the device is powered by a permanent magnet motor. Normal power input is 17.5 watts. Output speed is 20,000 rpm for the 50-v and 18,500 rpm for the 27-v version.

Circle No. 238 on Subscriber Service Card

Voltmeter/Ratiometer

Dana Laboratories, Inc., is marketing the Model 4020, a 4-digit, ac/dc digital voltmeter and dc ratiometer with a frequency range of 10 to 50,000 cps. The unit is designed to provide calibration-lab accuracy in on-the-line service. The Model 4020 features four ranges from ±0.0001 to ±1,000v; 1,000,000 to 1 common mode rejection; floating" input and output; total line isolation; solid-state circuitry; and 100-microvolt sensitivity.

Accuracy is 1 digit for dc readings, 0.1% of reading for ac readings from 50 cps to 1 kc, and 1% of full scale from 1 to 50 kc.

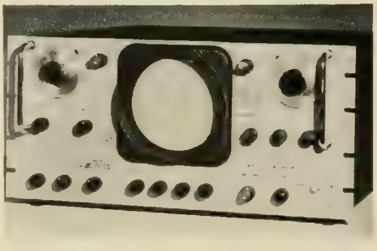
Measuring speed is 14 to 35 reading/sec, depending on function, polarity or range changes. The dc, ac or ratiometer functions and three reading modes —tracking, periodic or on-command— are selectable on the front panel control.

Circle No. 239 on Subscriber Service Card

Portable Spectrum Analyzer

Probescope Co., Inc., is marketing a spectrum analyzer Model LCA-1, which displays the frequency and amplitude of signals from 50 cps to 600 kc, linearly or logarithmically.

Its advanced circuitry requires no external line regulator. The device features 60 db displayed log range, independent or automatic optimum resolution, balanced or single-ended input, variable sweep rate of 30 sec/sweep to 60 sweeps/sec, and 10 kc and 100 kc markers good to 600 kc.



Circle No. 240 on Subscriber Service Card

Vacuum Furnaces

A line of high temperature, high vacuum furnaces is available from the Vacuum Products Div. of Varian Associates.

The cold-wall furnaces maintain a pressure of 5 x10^{-9} torr at temperatures above 2,000°C. The furnace system rapid-cycles to a 5 x 10^{-8} torr in two hours. Base pressures are below 5 x 10^{-10} torr.

Hot zone sizes range from 1½ x 4 in. to 6 x 12 in. During high vacuum pumping, the system functions as a closed unit. The furnace is automatically programmable for repeatability from charge to charge.

Circle No. 241 on Subscriber Service Card

Ammonia Dissociator

A pilot-model ammonia dissociator is available from C. I. Hayes, Inc.

Producing high-purity, low-dew-point atmospheres of 75% hydrogen and 25% nitrogen at the rate of 20 SCFH, the model (AD20) provides semiconductor manufacturers with a low-cost, experimental means of comparing the relative merits and costs of dissociated ammonia and hydrogen in alloying, soldering and brazing processes.

Circle No. 242 on Subscriber Service Card

Ultra-Short Potentiometer

An ultra-short potentiometer, ½ in. long, has been developed by Litton Precision Products, a division of Litton Industries.

Designated the MDU20-10, the device surpasses MIL-E-12934C specifications. Operational temperature range is —55 to 125°C. Stops are capable of withstanding 37½ lbs. of static torque.

Total resistance of the unit is 250 to 150K ohms. Power rating is 2 watts at 40°C derated to 0 watts at 125°C. Dual and multi-gang configurations are also available.

Circle No. 243 on Subscriber Service Card

Circle No. 28 on Subscriber Service Card

Precision Relay Sockets

Continental Connector Corp. has developed a Series 145-8 precision miniature relay socket for use with plug-in relays.

Models are available with 8, 14, or 20 contacts, including one type with removable contacts and solderless crimp terminations. Fixed contact types have a choice of solder cups and turrent terminals for direct wiring or dip solder pin termination for printed circuit assembly. Mounting styles include tapped inserts with studs for top chassis mounting, through hole, or tapped inserts with removable standoffs and screws for mounting on either side of chassis or panel. A polarizing hole or dot on the face of the stocket molding removes the possibility of inserting the relay incorrectly.

Circle No. 232 on Subscriber Service Card

Probe/Plug-in Unit

A dual-trace plug-in unit, Type 3S3, is available from Tektronix, Inc.

Developed for use with Types 561A, 564 (storage) and 567 (digital readout) oscilloscopes, the unit can operate in one of five modes. It features noise of less than 0.33 mv; a 0.35-nsec. risetime and sensitivities calibrated in five steps from 100 mv/cm to 5 mv/cm. An uncalibrated variable control extends the sensitivity to about 2 mv/cm.

Correct dot transient response can be achieved with source impedances of 25 to 300 ohms. A dc offset affords control of selected portions of signals having off-screen amplitudes. The device has a trace finder button to return a trace to the screen when driven off by a strong signal.

Circle No. 233 on Subscriber Service Card

Signal Source

Varian Associates' Bomac Div. has announced a microwave pulse signal source designed to operate as a transmitter in pulse radar applications.

The BLP-184 signal generator provides peak pulse of 250 kw with the Varian 6551 magnetron as the oscillator.

Features include variable output impedance, metering and monitoring provisions and stable internal trigger.

Circle No. 234 on Subscriber Service Card

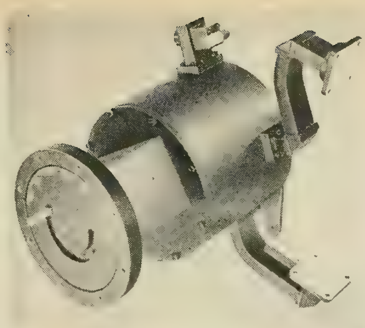
Wavemeter X-Band

Gombos Microwave, Inc. has announced a wavemeter design—a high "Q" model for X-band operation.

Designated Model G128, it has a loaded Q of greater than 40,000 over the frequency range of 8,765 to 8,835 mc. At room temperatures, accuracies are within 0.01%. Resetability is better than 0.005%.

Other specifications: transmission loss, 16 db maximum; undesired response, 20 db below desired transmission; frequency readout, direct; backlash, ±0.00125%.

Circle No. 235 on Subscriber Service Card



Tank Level System

International Resistance Co. has available a system to measure the level and weight of liquids in pressurized tanks.

Called the liquid level/weight gaging system, the unit consist of a transducer and a readout device.

The transducer is a differential pressure device that compares the pressure at the top of the tank with that at the bottom and is insensitive to tank pressure up to 2,000 psi.

The readout indicates the liquid level on a 5-in. vertical scale, and the remaining quantity in gallons or pounds on a four-drum counter. It features front panel adjustments and separate high and low limit alarm actuators adjustable over the entire range.

Circle No. 236 on Subscriber Service Card

Passive Multicoupler

Applied Technology Inc. has developed the Model PM-2, a passive multicoupler providing dual outputs from single inputs over frequencies of 0.55 to 10.75 gc. The range is broken down into five bands: 0.55 to 1.1 gc; 1.0 to 2.6 gc; 2.3 to 4.5 gc; 4.3 to 7.4 gc; and 7.0 to 10.75 gc.

Output to output/input isolation of more than 18 db is provided in the lower two bands and a minimum of 43 db isolation is provided in the upper three ranges. Maximum insertion loss, including power splitting, is 5.5 db in the lower bands and 9.0 db in the upper three.

The device is designed for standard 19-in. rack mounting and measures 13.5 x 5.25 x 19 in.

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PROJECT: F-111 and other Aerospace Programs

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PROPULSION AND THERMO DESIGN

AE, ME, or CE degree required plus experience in power plant installation design, fuel and oil system design and environmental control design.

RELIABILITY DESIGN SURVEILLANCE

AE, ME, CE or EE degree required plus design experience to monitor production designs for reliability considerations.

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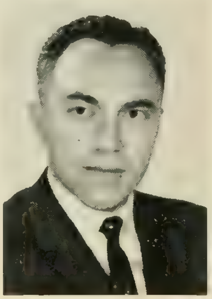
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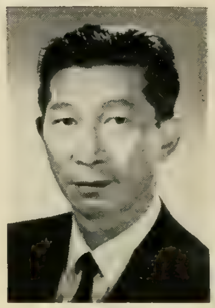
CHEUNG

John H. Rubel: Former Assistant Secretary of Defense for Research and Engineering, named vice president and director of planning for Litton Industries, Inc., Beverly Hills, Calif.

Dr. Manfred Eimer: Joined the Space-General Corp., El Monte, Calif., as director of engineering, space operation.

A. M. Kerzner: Promoted to corporate controller for Laboratory for Electronics, Inc., Boston.

Robert L. Schaeffer: Appointed comptroller of Winston Research Corp., Los Angeles.

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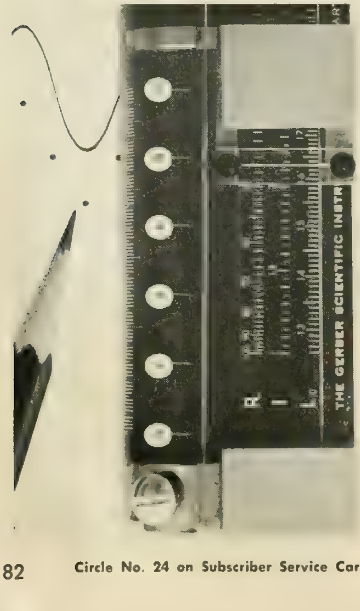

Samuel C. Finnell, Jr.: Appointed president of Amcel Co., Inc., and of Pan Amcel Co., Inc., New York City.

L. T. Cheung: Appointed manager of program control-*Atlas* Weapons Systems at General Dynamics/Astronautics, San Diego, Calif.

Arthur J. Kjontvedt: Named vice president of marketing by the Houston Fearless Corp., Los Angeles.

Francis L. Ross: Appointed western regional marketing manager of the Flexprint Products Div. of Sanders Associates, Inc., Los Angeles.

William Greening: Appointed production manager for Space Ordnance Systems, Inc., El Segundo, Calif.

Donald J. Kasun: Named engineering manager of the Westinghouse Cryogenic Systems Dept., Pittsburgh.

Col. Jesse Hamby: Administrative contracting officer at the Air Force Missile Test Center, transferred to Space Systems Div., Air Force Systems Command, Los Angeles, where he will be chief, contract management office.

Michael Hirsh: Appointed vice president in charge of marketing for the Benson-Lehner Corp., Van Nuys, Calif.

Brig. Gen. John G. Zierdt: Appointed commanding general, U.S. Army Missile Command, Redstone Arsenal, Ala.

Dr. Karl H. Houghton: Joined the Douglas Aircraft Co.'s Missile and Space Systems Div., Santa Monica, Calif.

Dr. Jacob A. Randmer: Joined Machlett Laboratories as chief engineer for the power tube operation, Springdale, Conn.

Dr. Ulrich Heidelauf: Appointed director, intelligence and exploration systems for the Raytheon Co's Space and Information Systems Div., Lexington, Mass.

Orville D. Page: Named product manager-telemetry and surveillance equipment, at Vitro Electronics, Silver Spring, Md.

Paul M. Olson: Appointed sales representative for General Electric's Wire and Cable Dept., Bridgeport, Conn.

Albert M. Warner: Appointed director of industrial relations for Sylvania Electric Products, Inc., New York City.

Cmdr. Robert H. Epley (USN Ret.): Joined the Economics Div. of the Center for Naval Analyses, Arlington, Va.

A. G. Cole: Named manager of the Contract Administration Dept. of Tracerlab's Reactor Monitoring Center, Richmond, Calif.

Arthur J. Cook, Jr.: Appointed eastern regional manager for Hathaway Instruments, Inc., Towson, Md.

Dr. Robert J. Raudebaugh: Appointed technical assistant to the manager of International Nickel Co.'s Research Laboratory, Bayonne, N.J.

Clifford W. Kropp: Appointed sales engineer at Vitro Electronics, Silver Spring, Md.

Walter E. Fiedler: Appointed field systems manager for the Advance Planning Dept. of Cook Electric Co.'s Tech-Center Div., Morton Grove, Ill.

Perry R. McCarty: Appointed treasurer of Beckman Instruments, Inc., Fullerton, Calif.

Bernard Better: Appointed vice president of the Engineering and Research Div. for Scully-Jones and Co., Chicago.

F. E. Shashoua: Appointed manager electro-optics and thermoelectrics at Radio Corp. of America Defense Electronic Products, Camden, N.J.

Bill Shurtleff: Appointed manager microwave marketing at Motorola's Chicago Military Electronics Center.

Walter W. Ross: Appointed manufacturing manager for the Portland Coppe and Tank Works, Inc., Portland, Me.

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William L. Rose: Appointed executive vice president of Milgo Electronic Corp., Miami.

Ian M. MacLachlan: Named director of commercial relations at Martin Marietta Corp., New York City.

Mark C. Haselman: Named group vice president, defense products divisions, Altamil Corp., Indianapolis.

Gerald W. Heidisch: Appointed general auditor of Electronic Communications, Inc., St. Petersburg, Fla.

Joseph D. Kenrick: Appointed accounting and auditing director of General Telephone and Electronics Corp., New York City. **John E. Hammel** appointed budget director.

Robert L. Casselberry: Named manager of planning for standard products at General Electric's Communication Products Dept., Lynchburg, Va.

Charles H. Keller: Appointed corporate director of advertising and public relations for the Hoover Ball and Bearing Co., Ann Arbor, Mich.

Douglas G. Harvey: Named assistant director, auxiliary power systems, for Martin Co.'s Nuclear Div., Baltimore.

James H. Carpenter: Appointed manufacturing engineering manager of the Panelyte Industrial Div. of Thiokol Chemical Corp., Trenton, N.J.

Dr. Derek Angier: Appointed director of research for Radiation Applications, Inc., Long Island City, N.Y.

Max A. Robinette: Named sales manager at Semiconductor Specialists, Inc., Chicago.

Harry S. Malutich: Appointed manager of manufacturing for the Electronics Div. of Erie Resistor Corp., Erie, Pa.

Sanford S. Maremont: Elected president of Rocket Power, Inc., Mesa, Ariz.

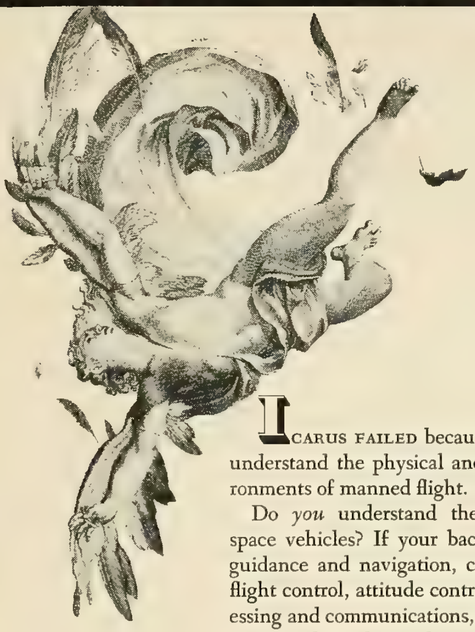
Irving Oscar: Joined the research and analysis division of Booz, Allen Applied Research, Inc., Chicago, as a principal engineer in the Washington, D.C. office.

Bradford H. Vineall: Appointed quality assurance manager of Quantic Industries, Inc., San Carlos, Calif.

Jack Rosenberg: Joined Wyle Laboratories as chief engineer for the Manufacturing Div., El Segundo, Calif.

William N. Montgomery: Promoted to the position of general defense coordinator by the Michigan Bell Telephone Co., Detroit.

Robert R. Driscoll: Joined the marketing Dept. of Washington Technological Associates, Inc., Rockville, Md., as an applications engineer.



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SEPTEMBER

AIAA Meeting on Engineering Problems of Manned Interplanetary Exploration, Cabana Motor Hotel, Palo Alto, Calif., Sept. 30-Oct. 1.

IEEE Canadian Electronics Conference, Exhibition Park, Toronto, Sept. 30-Oct. 2.

OCTOBER

Eighth National Symposium on Space Electronics, Institute of Electrical and Electronics Engineers, Fontainebleau Hotel, Miami Beach, Oct. 1-3.

National Aerospace Nuclear Safety Topical Meeting, American Nuclear Society, sponsored by Los Alamos Scientific Laboratory, AEC Albuquerque Operations Office, AF Special Weapons Center, AF Directorate of Nuclear Safety, Sandia Corp., and University of New Mexico, Albuquerque, Oct. 1-3.

Symposium on Physics and Nondestructive Testing, sponsored by Southwest Research Institute, San Antonio, Tex., Oct. 1-3.

Second National Symposium, Society for Information Display, Barbizon Plaza Hotel, New York City, Oct. 3-4.

AIEE Fall General Meeting, Pick-Congress Hotel, Chicago, Oct. 6-11.

IRE National Communications Symposium, Hotel Utica, Utica, N.Y., Oct. 7-9.

Corrosion of Military Equipment Committee, National Association of Corrosion Engineers, Admiral Semmes Hotel, Mobile, Ala., Oct. 8-9.

International Conference on Electromagnetic Relays, Tohoku University, Sendai, Japan, Oct. 8-11.

21st Annual Aerospace Electrical/Electronics Conference, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Oct. 9-11.

1963 General Conference, Federation Aeronautique Internationale, Mexico City, Oct. 12-21.

Materials Handling Conference, sponsored by ASME, AIEE and IRE, Chamberlain Hotel, Newport News, Va., Oct. 14-15.

Advanced Purchasing and Subcontract Management Course, sponsored by the National Defense Education Institute, Charter House Hotel, Cambridge, Mass., Oct. 14-18.

Course on Space Power Systems, sponsored by George Washington University's College of General Studies, Airlie Center, Warrenton, Va., Oct. 14-25.

Users of Automatic Information Display Equipment Annual Meeting, Carillon Hotel, Miami Beach, Oct. 15-17.

Eighth Symposium on Ballistic Missile and Space Technology, sponsored by AF Space Systems Div. and Aerospace Corp., Naval Training Center, San Diego, Calif., Oct. 15-18.

Second Annual Technical Colloquium, Society of American Value Engineers, Airport Marina Hotel, Los Angeles, Oct. 16.

AIAA/CASI, RAeS Ninth Anglo-American Conference, Massachusetts Institute of Technology, Cambridge, Oct. 16-18.

American Vacuum Society, National Symposium on Vacuum Technology, Statler-Hilton Hotel, Boston, Mass., Oct. 16-18.

Fourth Annual One-Day Technical Symposium on Information Processing, University of Maryland, College Park, Oct. 17.

Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, IEEE, Emerson Hotel, Baltimore, Oct. 21-23.

American Society for Metals, Annual Meeting and National Metals/Materials Show and Exposition, Public Auditorium, Cleveland, Oct. 21-25.

23rd National Convention, Society for Nondestructive Testing, Pick-Carter Hotel, Cleveland, Oct. 21-25.

Ninth Conference on the Design of Experiments in Army Research, Development and Testing, Redstone Arsenal, Huntsville, Ala., Oct. 23-25 (by invitation only).

Human Factors Society Annual Meeting, Ricky's Hyatt House, Palo Alto, Calif., Oct. 23-25.

Optical Society of America Annual Meeting, Sherman House, Chicago, Oct. 23-25.

National Electronics Conference, McCormick Place, Chicago, Oct. 28-30.

13th Annual Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 28-29.

Western States Section of the Combustio Institute Fall Meeting, University o Southern California, Los Angeles, Oct. 28-29.

IRE-PTGNS International Symposium o Plasma Phenomena and Measurement El Cortez Hotel, San Diego, Calif. Oct. 29-Nov. 1.

IEEE 1963 Electron Devices Meeting Sheraton-Park Hotel, Washington D.C., Oct. 31-Nov. 1.

NOVEMBER

AIAA Vehicle Design and Propulsion Co ference, Air Force Systems Comman Wright-Patterson Air Force Base, Day ton, Ohio, Nov. 4-6 (classified).

IEEE Northeast Electronics Research an Engineering Meeting (NEREM), Con monwealth Armory/Somerset Hote Boston, Nov. 4-6.

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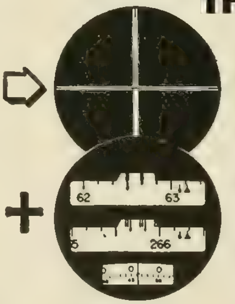

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The Reasons Why

THE PRESIDENT of the United States has asked a series of questions of which the most basic is:

"Why, therefore, should man's first flight to the Moon be a matter of national competition?"

We propose here to answer those questions and to give the reasons why. But let us first look at the record. Let us first make certain we understand just what President Kennedy proposed in his speech before the United Nations on September 20. He stated, in the course of that speech:

"Finally, in a field where the United States and the Soviet Union have a special capacity—in the field of space—there is room for new cooperation, for further joint efforts in the regulation and exploration of space. I include among these possibilities a joint expedition to the Moon.

"Space offers no problem of sovereignty; by resolution of this assembly, the members of the United Nations have forsworn any claims to territorial rights in outer space or on celestial bodies, and declared that international law and the United Nations Charter will apply.

"Why, therefore, should man's first flight to the Moon be a matter of national competition? Why should the United States and the Soviet Union, in preparing for such expeditions, become involved in immense duplications of research, construction and expenditure? Surely we should explore whether the scientists and astronauts of our two countries—indeed of all the world—cannot work together in the conquest of space, sending someday in this decade to the Moon, not the representatives of a single nation but the representatives of all of our countries." Those were the words of our President. We are told that earlier drafts of the speech included no reference to the lunar effort, that this proposal for a joint expedition was a last-minute insertion.

Therefore, before replying to the questions, let us examine some of the earlier statements which Mr. Kennedy himself has made in regard to *Apollo.*

When the President proposed to Congress in May, 1961, that the nation embark on the multibillion-dollar project to place an American expedition on the Moon, he suggested it might be the key to our future on Earth.

With Congressional approval, this nation set out on a determined effort to land a team of astronauts on the Moon in this decade—and to accomplish that feat ahead of the Soviet Union.

As recently as July 17 the President declared that the capacity to dominate space was "essential to the United States as a leading free world power." He called it an area which could affect the national security and again emphasized U.S. determination in regard to the lunar effort.

Suddenly, the urgency has vanished, the interest in the national security has been swept aside, the race has been abandoned, and we find the President asking:

"Why, therefore, should man's first flight to the Moon be a matter of national competition?"

We offer these answers:

1. Because it is important to the survival of the United States that we develop the science and technology which gives us the capacity to send a manned expedition to the Moon and back.

2. Because there is national prestige at stake. Do not believe for a moment that achievement of a successful lunar landing by either the Soviet Union or the United States will not immeasurably bolster the political status of that nation.

3. Because it is important to our military security. We are in complete accord with the Administration position that weapons of mass destruction must be kept out of outer space. In order to assure that this ban is carried out, we must possess the capability to operate in space, to detect, intercept and inspect the space vehicles of other nations.

4. Because we are engaged in an economic war with the Soviet Union. Mr. Khrushchev, acknowledging the futility of nuclear war, has made it abundantly clear that he believes the Soviet Union can defeat us in the economic arena. His famed "we will bury you" statement was made in reference to economic competition, not military combat. Given the gross national product of the two nations, the lunar effort is a far more crushing burden to the Soviet economy than to ours.

5. Because we believe in finishing what we start. Obviously, a $20-billion lunar project becomes something of a liability for an Administration proposing extensive tax cuts. But we do not accept political expendiency as an excuse for a stretchout. This richly endowed nation can afford the financial burden of the Moon program.

There can be no question at this stage of any extensive joint Soviet-American effort on lunar hardware. In addition to the security problem, the projects are too far along from an engineering standpoint for such cooperation to be practical.

NASA Administrator James E. Webb explained in Houston last week that President Kennedy was referring basically to an exchange of information, with perhaps agreement on a common lunar landing site. Mr. Webb said there has been some misunderstanding about the President's proposal and that Mr. Kennedy has not changed his earlier views.

WE FIND THIS hard to square with Mr. Kennedy's question of why the flight to the Moon should be a matter of national competition, with his question as to why the U.S. and Soviet Union should be involved in a vast duplication of research, construction and expenditure. And with his suggestion that we might send to the Moon in this decade "not the representatives of a single nation, but the representatives of all our countries."

We favor cooperation and an exchange of information with the Soviets in this field, but we reject such a naive internationalist approach to the lunar project. It can only harm the U.S. effort to the benefit of the Soviet Union.

William J. Coughlin

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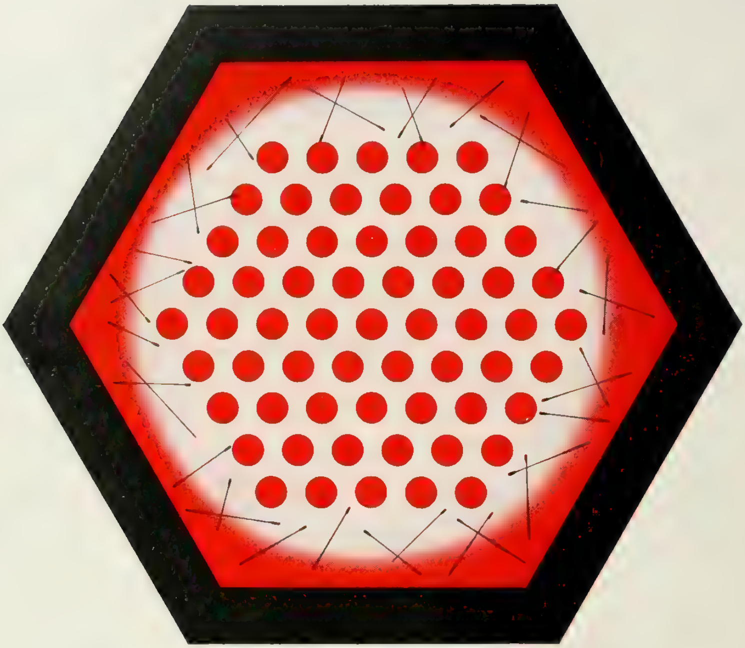

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Extensive preliminary studies of advanced mobile and transportable nuclear power plants have been made by Aerojet-General Nucleonics, using proven technology and components derived from America's first mobile nuclear power plant, the ML-1. The ML-1 is being developed by AGN for the Atomic Energy Commission and the Army Corps of Engineers. ■ The AGN studies covered the power range from 100 kw to 3 Mw—with applications ranging from the Antarctic to space, and emphasis on economy, reliability, and safety. ■ Fundamental to these studies: a practical, straight-forward fuel element successfully operated for 10,000 hours at full power, at a coolant temperature of 1200°F... with no fission product release... and no sign of failure. ■ Based on these results, core lifetimes of several years are clearly feasible. ■ For information on AGN's programs in mobile nuclear power, write for AGN Active File #2.

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T.M.

OCTOBER 7, 1963

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HE WEEKLY OF SPACE SYSTEMS ENGINEERING

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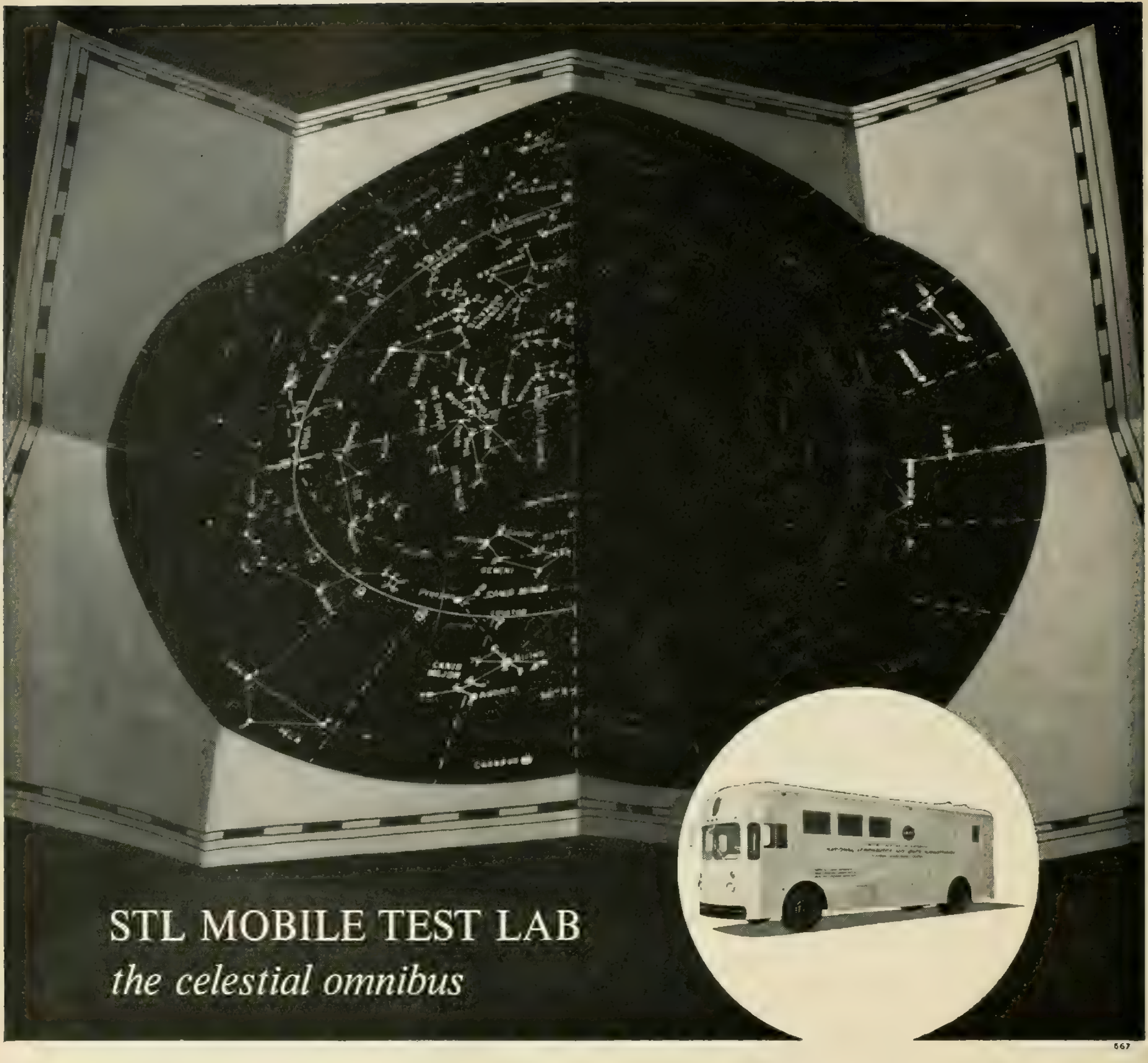

667

When a spacecraft carries as many as 50 experiments on a mission, it demands ground support equipment with broad capabilities to chart its course. Mobile Test Labs, designed and built by TRW's Space Technology Laboratories can simulate, measure, record and evaluate 64,000 bits of telemetry data each second. Operating under manual, semi-automatic, or completely automatic control these vehicles utilize telemetry data for on-line testing and monitoring of spacecraft electronic systems during integration, assembly and pre-launch test. STL scientists and engineers are using this equipment to test NASA's Orbiting Geophysical Observatory (OGO), Air Force-ARPA 823 spacecraft, and other classified vehicles.

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THE COVER

Electrostatic gyro is placed in gimballed test table for checkout at Honeywell's Aeronautical Div., Minneapolis. Developed under an AF Aeronautical Systems Div. contract, the gyro is representative of the advanced concepts covered in M/R's special report beginning on page 31.

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45,800 copies this issue

When the first Pershing battalion was formed it decided on the slogan, "every Pershing in the pickle barrel." And when the troops fired their first three rounds from Cape Canaveral, do you know what was reported to the commanding officer? "Mission accomplished. Three rounds in the pickle barrel. Pershing, sir."

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SENIOR LEVEL POSITIONS IN GUIDANCE AND CONTROL SYSTEMS

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Soviet EMP Threat

To the Editor:

I read your article, "Soviets May Have Ultimate ABM" (M/R, Sept. 16, p. 14) and needless to say I concur. It read like a report of my "soapbox" briefings to all the major commands throughout the U.S.A. and Canada these past four years. I even used the phrasing referring to the "Maginot Line" and "Siegfried Line."

I am enclosing a copy of the reprint of our original paper and a working outline of the new paper, as well as an illustration of the EMP effects that is in the new paper.

Our intent was to get the people responsible for the criteria in the engineering design of weapons systems, command and control, and support networks, to really define the *total* environmental considerations.

You mentioned the availability of information on a "need to know basis." This is fine if the engineering agency knows he needs to know. This is the whole problem. So many things are overlooked in the development of a system. "Retro-fits" are commonplace and sweeping problems into a classified file is a very convenient solution.

Many of the problems involved with the EMP phenomena could be easily solved if all of the information *now* available were properly correlated to the problems at hand. More nuclear tests would be a waste of time, unless *knowledgeable* people were instrumenting the tests and evaluating the results from an *operational systems* standpoint.

We feel that fast-response transient protection is a must for on-line electronic gear. And a reappraisal of all this rush to solid-state circuitry for "shake, rattle, and roll" reliability. A combination of transient protection (Isotype Tubes), Vacuum Tubes, Solid-state Circuitry, and attention to design and installation *fundamentals* would go a long way in the "electrical hardening" process. We have several workable, inexpensive, and proven solutions. A combined approach with a look at *fundamentals* and *diversity* in a *real* sense is required. We think this is not being implemented in many areas.

EMP "experts" are suddenly coming out of the woodwork with an "all knowing the problem" reference. Several years ago we were accused of "defining a solution to a problem that didn't exist."

I will continue to watch M/R's coverage of this subject.

John A. Kuypers
Stanford Linear Acceleration Center
Stanford University
Stanford, Calif.

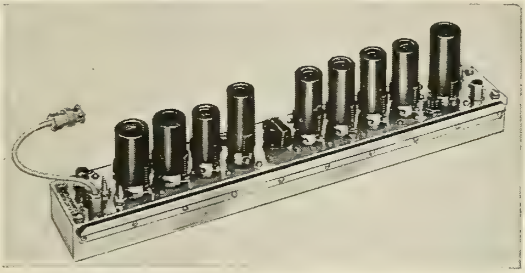
Test-Ban Treaty

To the Editor:

In my opinion, the generalized failure of leadership touched a new betrayal low

UNEQUALLED!

The **design** of RS Electronics miniature i.f. amplifiers has been widely imitated, but their **reliability** never equalled. After an RSE amplifier is placed in service, it doesn't come back for repairs.



RSE Model 905 miniature i.f. amplifier typically provides a noise figure of 1.5 db at 30 Mc center frequency with 110 db gain. Also available with 60 Mc center frequency.

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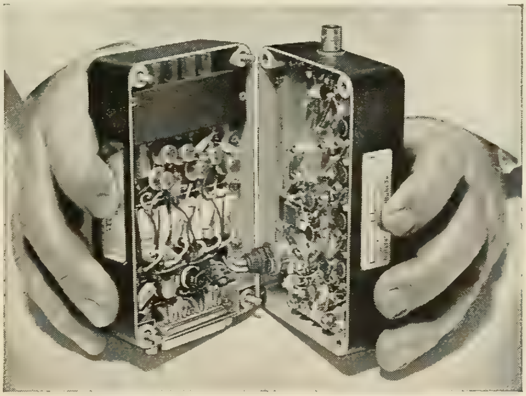

RSE command receiver decoder package. Typical specifications: frequency, 406-549 Mc • sensitivity, five microvolts • RFI meets MIL-I-26600 • environment MIL-E-5422 E Class I • size and weight, 43 cu. in., 35 oz. • outputs, six independent commands.

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when the Senate passed the test-ban treaty.

Re your articles on the perfidious test ban, could you tell me where I could find lay-language publications on electromagnetic pulse technology? I'd like to read up on it.

Meanwhile, for what it is worth, I try to arouse the sleeping American public to its danger.

Barclay K. Read
McLean, Va.

Unfortunately, as far as we know no non-technical EMP literature is available —Ed.

Joint Moon Proposal

To the Editor:

Your editorials are excellent!

Regarding "Soviets Eye Joint Moon Landing" (M/R, Sept. 23, p. 14), such a venture would prove to be more lunatic than lunar. Would Russia, as a partner, share equally in our military "spinout," and, if so, would we share equally in Russia's? Have we ever?

Our scientist-engineers have already spent years on the lunar mission designs. It's not possible to alter these, even partially, to Russian designs without imposing huge delays and costs. Just a few of the handicaps would be distance, language, philosophy, military and trade secrets, increased costs, Russian treachery, and politics. Uncle Sam would foot the increased cost, of course.

Most of our space team members are enthusiastic and dedicated in spite of the usual government stupidity. President Kennedy's offer to share our team's designs is tantamount to a football coach's offering to share the team's plays with the opposing team, except that this is for keeps—not touch football. Even the proposal of such a sellout is bound to remove spirit from our team.

The world will interpret this ill-advised offer as a sign of weakness. Most Americans believe our free enterprise system—even starting 'way behind—can surpass the faltering Russian team. Totalitarianisms can't offer the same free spirit, incentive, or ultimate achievement. The chance to prove this dramatically will be lost forever if we are foolish enough to become partners in this venture.

Thomas M. Morse
Planning Engineer
Santa Maria, Calif.

To the Editor:

The *Jamestown Sun* reports that, in your address to North Dakota editors at the University of North Dakota, you are of the opinion that North Dakota and Minnesota ought to get on the gravy train of space contracts.

In your position you must be well aware that the billions in appropriations for space and Moon projects which the Kennedy Administration sold Congress and the public were based on the argument that the United States must put the first man on the Moon. This, presumably, was to improve our "image," having lost out to

BOEING OPENINGS ON SATURN S-1C

Boeing has primary developmental, building and test responsibility for NASA's S-1C Saturn V first-stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

This rapidly expanding program provides unique advancement advantages and ground-floor opportunities to physicists, mathematicians and engineers with the following specialties: electrical/electronics, propulsion, structural design, systems test, manufacturing, tooling, facilities, aerodynamics, cryogenics and high vacuum technology.

Salaries are commensurate with all levels of education and experience. Minimum requirement is a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly hired personnel.

Saturn assignments are in New Orleans as well as in Huntsville, Alabama. Other missile and space programs at Boeing's Aero-Space Division include the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle.

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BOEING
AERO-SPACE DIVISION

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(Continued from page 10)

Russia in superiority of space flights, in spite of the billions poured into our efforts.

In your position you must be well aware that Mr. Kennedy has now become an advocate for cooperation with Russia on the Moon project. "Let's be big about the whole thing and have the man who gets to the Moon a representative of the whole world." Russia appears not to be interested in this proposition and, in fact, not especially interested in the Moon.

As to the argument that the billions spent on space are expended in the United States and thereby contributing to the economic well-being of the country, I would point out to you that those billions are confiscated from the pocketbooks of the U.S. taxpayers, and it is more than possible that those billions, left in the hands of the people who earned them, would contribute to the well-being of the country by enabling manufacturers to modernize their plants and invest in new projects indigenous to this planet, rather than one in outer space. They also would allow the workers a less restricted income, to which they have a right.

In light of Mr. Kennedy's announcement of Sept. 26, I hope you will amplify your discussion on space projects by now advising your audience that Mr. Kennedy insists that space appropriations are not to be cut, even though Russia should join in their development. It appears, then, that we are to share Knowledge, but the American taxpayer will still foot the bill.

What is needed in this country for economic well-being is a 100-cent dollar, instead of a 44-cent one, a drastic curtailment in Federal spending, a balanced budget to restrain the flight of our gold among other things, and a return to Constitutional government instead of government by Executive fiat.

Jacqueline W. Murphy
Rutherford, N.J.

AF Scientists

To the Editor:

"Let not thy Right Directive know, what thy Left Directive is doing" describes the efforts of the Air Force to attract competent engineers and scientists to its service. While with the one hand they hire knowledgeable, conscientious men, the other hand then places them under supervisors who *hate, resent, abominate* degreed personnel. These supervisors set about then to muzzle and chain these men to their desks, make them check papers, and read farcical reports, until they either resign in disgust or join the Cosa Nostra of the three I's of Inefficiency, Inertia and Indolence.

To avoid these facts being made public, they originate further directives that forbid communicating with members of Congress, except through channels, or communicating with the press, except through channels. These channels are as deep as the English Channel and about as effective.

There is a knock at my door. MP's already, and I have not sent the letter yet.

Tony Berger
Burbank, Calif.

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Imagine the problem this creates for America's scientists trying to find ways to guide our astronauts on journeys to distant planets. Not only is the earth moving at astonishing speeds, but all the planets are moving too, and our entire solar system is moving at the same time.

One of the most difficult problems in the conquest of space is guidance . . . to be able to launch a vehicle from the moving earth, have it speed through a whirling universe, and then land precisely at a moving destination millions of miles away.

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The Autonetics Division of North American is hard at work in the field of navigation. It was Autonetics that designed and built the navigation systems which guide Polaris submarines for months beneath the ocean and Minuteman missiles for brief minutes of highly accurate flight through the skies.

Today the broad know-how of North American in guidance, space vehicles and rocketry—and in simulating and managing complex systems—is solving the intricate problems of navigation in outer space.

And when our first space explorers set forth, they will be guided with extraordinary precision in a universe that is always on the move.

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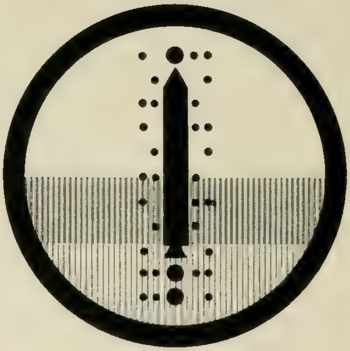

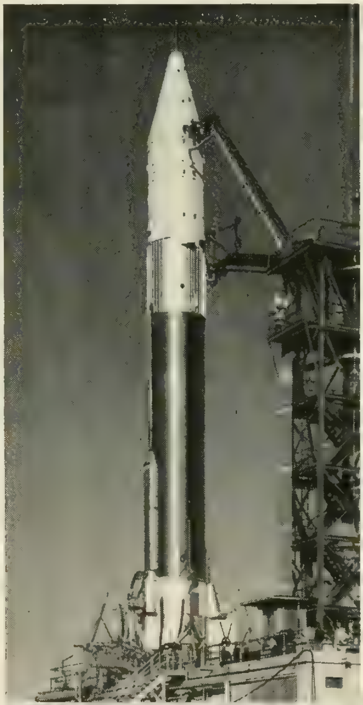

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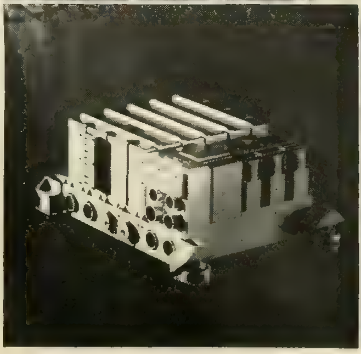

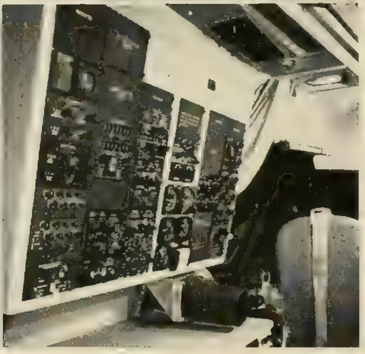

G3-18

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The Countdown

WASHINGTON

Gemini Timetable in Further Trouble . . .

The first manned *Gemini* flight is now slipping into early 1965. Earliest date for the first unmanned orbital flight is January, 1964, putting the first manned flight 18 months behind its earlier schedule and probably delaying until 1966 the first rendezvous mission—originally set for 1965.

. . . And Headquarters Grows Restless

Slippages in *Gemini* and *Apollo* are causing increased dissatisfaction at NASA headquarters with performance at the Manned Spacecraft Center in Houston. Officials are currently studying ways to revamp MSC organization to get better efficiency and improve relations with industry contractor teams.

Twenty Megabucks for Paraglider System

NASA has signed a definitized contract with North American Aviation for the paraglider landing system for the *Gemini* spacecraft. Total value of the award is $20,000,015. Slightly more than $10 million has already been paid to the company.

Bureau Backs off from Nimbus

The Weather Bureau has told NASA that it won't provide funds for three operational *Nimbus* weather satellites. The Bureau said *Nimbus* is both too expensive and 18 months behind schedule (see p. 20). It added that it is studying other, unnamed satellites that it feels will be more suitable for meteorological purposes.

Streamlined Pop-up for Polaris

A new steam ejection system using solid rockets for heat will pop *Polaris A3's* from their underwater launch tubes in forthcoming *Polaris* subs. First tested in a successful 1,600-mi. shot from USS Observation Island last week, the system employs 18-in. rockets mounted outside each launch tube. Rocket exhaust passes into a water chamber feeding steam into the tube base. System eliminates heavy complex of pipes, valves and air flasks in present compressed-air ejection technique. Hercules Powder and Navy's Indian Head Propellant Plant are making the rockets. Allegany Ballistics Lab and Indian Head helped develop the new system.

Apollo Strakes Dropped

NASA has abandoned the narrow strakes planned on the *Apollo* command module to prevent it from stabilizing in an apex-forward attitude during a pad abort. Engineers now are considering use of the escape rocket tower for this purpose. Spent motor would be ejected from the top of the tower structure, but the structure itself would be retained until recovery chutes deployed. Sheet-metal surfaces are being added to the truss structure to increase aerodynamic stabilizing force.

Computer Language Under Study

Defense Communications Agency is looking at the possibility of standardizing computer programming language for the National Military Command System. Problem is to see that the leaders in the national chain of command, and computers themselves, use more of the same language in input and readout of information leading to strategic decisions. Development of a more responsive and flexible system will involve integration of a number of different command and control systems.

INDUSTRY

Aerojet's First Cash Dividend in 15 Years

Aerojet-General's board of directors has declared a quarterly cash dividend of 12½ cents per share—first the company has paid since Oct. 25, 1948. The board also declared a 2% stock dividend. Both dividends are payable on Dec. 16 to shareholders on record as of Nov. 15. No fractional shares or script certificates will be issued in connection with the stock dividend, but fractional interest will be sold on open market and proceeds distributed to shareholders. The board said it hopes to make it a policy to issue quarterly dividends from now on.

Levy Given Broad Authority at Raytheon

Lawrence Levy, who joined the Raytheon Company in August in the new post of vice president for corporate development, will wear more corporate hats than any previous vice president of the firm. He will take over the responsibilities formerly handled by Thomas G. Lanphier, Jr., who resigned on Sept. 26 from his post as vice president-corporate planning. Among other things, Levy will also be in charge of marketing.

Fixed-Price Takes Hold at AFMTC

Percentage of fixed-price contracts at Air Force Missile Test Center, Cape Canaveral, has more than doubled in one year. In FY 1962, the fixed-price share was 41%; in FY '63 it jumped to 87.8%. During the same period, the volume of cost-plus-fixed-fee awards dropped from 52% to 9.7%. AF spokesmen credit "an educational program leading to preparation of technical exhibits which reflected greater detailed specifications adaptable to competitive procurements."

INTERNATIONAL

New Space Meeting Urged

The International Astronautical Academy has proposed a second Man in Space Symposium in June, 1964, at UNESCO in Paris. IAA officials believe prospects are promising for the suggested lunar international laboratory in view of President Kennedy's overtures toward U.S.-USSR space cooperation.

British Comsat Plans Jelling

Britain's cabinet will receive within the next few weeks a detailed report on future British communications satellite systems. The Royal Aircraft Establishment says it has about finished a "definitive" study that may enable the government to decide whether or not to go ahead with a system to be launched by the *Blue Streak*. The report will provide cost and time analyses of 15 different types of systems.

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Direct your inquiry to:
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The Applied Physics Laboratory
The Johns Hopkins University

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The Missile/Space Week

Nike-X Pact Awarded

The Army has issued a $213,385,000 contract for continued *Nike-X* antimissile system development and testing to Western Electric Corp.

Although it was the largest single missile award ever made by the Army, the contract did not include funds for production or deployment of the system.

Western Electric will perform *Nike-X* development work at plants in North Carolina and Pennsylvania. Testing will take place at White Sands Missile Range, N.M., and at Kwajalein Island.

Subcontractors sharing in the funding include: Avco Corp., Cornell Aeronautical Laboratories, Douglas Aircraft Co., General Electric Co., Martin Co., Raytheon Co., Sperry-Rand Corp. and Sylvania Electronic Products.

Martin is developing the *Sprint* missile portion of the system and is responsible for *Sprint* engineering services.

No MMRBM's for NATO

The Administration remains firmly opposed to deploying the *Mobile Medium Range Ballistic Missile* in Europe, despite reported recommendations to do so from NATO chief Gen. Lyman L. Lemnitzer.

A State Department spokesman last week repeated opposition which countered earlier proposals made by Gen. Lauris Norstad, Gen. Lemnitzer's predecessor. Administration leaders are unimpressed by the argument that *MMRBM's* are needed to present a more flexible and diversified defense against Soviet armies.

NATO Supreme Headquarters believes that Europe needs a better mix of nuclear and conventional arms. The military heads also feel that *MMRBM's* would be useful against Soviet troop commitments to small aggressions. The Administration favors *Polaris* subs as less vulnerable systems.

In Washington, the Air Force *MMRBM* proposal suffered a $100-million cut to $43 million in the House. The Senate restored $60 million, but important members of Congress are dubious of DOD backing for the request. The Joint Chiefs, however, testified in favor of the *MMRBM* request earlier this month.

Guidance system development could go ahead under the minimal House figure, and parts of Phase II development could proceed if the Senate restoration survives conference.

JFK Proposal Puzzles Hill

Space-minded Congressmen are still perplexed about President Kennedy's space program intentions, despite a Presidential letter to Rep. Albert Thomas (D.—Tex.) stating that his recent proposal for a joint U.S.-Soviet lunar landing did not indicate a downgrading of U.S. space goals.

Rep. Olin Teague (D—Tex.) told MISSILES AND ROCKETS that he is still awaiting an answer to a letter he sent the President pointing up specific problems of national security that the President's statement may affect.

Teague said he still felt that "he sure pulled the rug out from under us."

Other congressmen predict that, no matter what comes from the President's proposal, the Administration will have a hard time getting its space budget through. A vote is expected this week on the NASA appropriation bill.

The Kennedy letter to Thomas referred to his statement in the United Nations as "a direct development of a policy long held by the United States Government." The President told Thomas that the great national effort, as pledged by him in 1961, and the "steadily stated readiness to cooperate" are not conflicting policies, but "mutually supporting elements of a single policy."

Shots of the Week

SNAP-9A, the third lightweight radioisotope-fueled thermoelectric generator to be used in a satellite, was successfully launched Sept. 28 from Vandenberg AFB, Calif., in a Department of Defense satellite carried aboard an Air Force *Thor-Able-Star* vehicle.

Signals from electricity generated by the AEC-developed nuclear power source are being received from the satellite.

The Martin Co.-built generator, designed to provide 24 watts of dc current, is the first all-nuclear power system used in a satellite. Two previous nuclear generators orbited by

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Plant Site Report

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DOD derived a part of their electric power from solar cells.

The generator is 20 in. in diameter, including fins, and 10 in. high. It is mounted on one end of the satellite. Designed lifetime is five years.

Other shots of the week:

- NASA fired an *Aerobee 150* rocket bearing a 235-lb. instrument payload from White Sands Missile Range, N.M., Oct. 1. Mission was to study ultraviolet radiation and the Sun's cornea.
- The U.S.S. Andrew Jackson made its *Polaris* firing debut Oct. 1 with a successful launch of an *A2* model.
- The second NASA-Japanese ionospheric sounding experiment was successfully conducted with an *Aerobee 150-A* rocket Sept. 28.
- The Army on Sept. 27 successfully fired the fourth in a series of *Pershing* shots from Blanding, Utah, to White Sands Missile Range, N.M.
- The Air Force launched a *Scout* vehicle bearing a secret payload from Vandenberg AFB, Calif., Sept. 27.
- The Navy, using a new steam launch technique, successfully fired a *Polaris A3* from the carrier, Observation Island, Sept. 26 (see p. 17).
- The *Minuteman* scored its 14th succesful West Coast firing Sept. 26 from Vandenberg AFB, Calif.

MITRE to Work on NMCS

The MITRE Corp., Bedford, Mass., has begun relocating 25 scientists, and engineers to a new Washington, D.C., facility for work on the National Military Command System.

The Defense Communications Agency of the Dept. of Defense, responsible for the top priority program, announced recently that MITRE would assist them with technical planning and design of NMCS, along with the technical integration of the NMCS with the world-wide military command and control system.

Present plans call for MITRE to increase staff support to DCA in the next 9 months to a level where contract cost would be slightly more than $1 million for fiscal 1964. C. A. Zraket, formerly director of MITRE's system planning, research and advanced planning, will head up the group in Washington, D.C.

According to DCA, major improvements in the system are expected within the next three or four years. These will be largely in the area of automated aides and communications designed to assist national commanders in making decisions and in controlling forces.

General guidelines for the overall system require that it be more responsive, flexible and survivable than any now in existence. The system's survivability is being attained through mobility and redundancy. Primary, alternate and mobile (airborne and seaborne) command posts are already established.

Nimbus Replacement Sought

The Commerce Department will decide soon what satellite it will use to replace the *Nimbus* weather satellite. The Department informed NASA last week that it will not fund *Nimbus* (M/R, Sept. 23, p. 15).

Several replacements are being considered, according to Commerce Department officials. A "rolling wheel" *Tiros* and the Air Force's *SAMOS* are believed to be getting special attention.

If *SAMOS* is chosen, it would shift emphasis on a civilian weather satellite system from NASA to the Defense Department.

The Weather Bureau's decision to scrap *Nimbus* is based on the belief that the program is now 18 months behind schedule and is also too costly. The Weather Bureau has earmarked $45 million for the program. This information was contained in a recent letter from Dr. J. Herbert Holloman, Assistant Secretary of Commerce for Research and Technology, to NASA Associate Administrator Dr. Robert Seamans.

Nimbus also has a comparatively short useful lifetime (six to 12 months), and can do only a limited number of tasks.

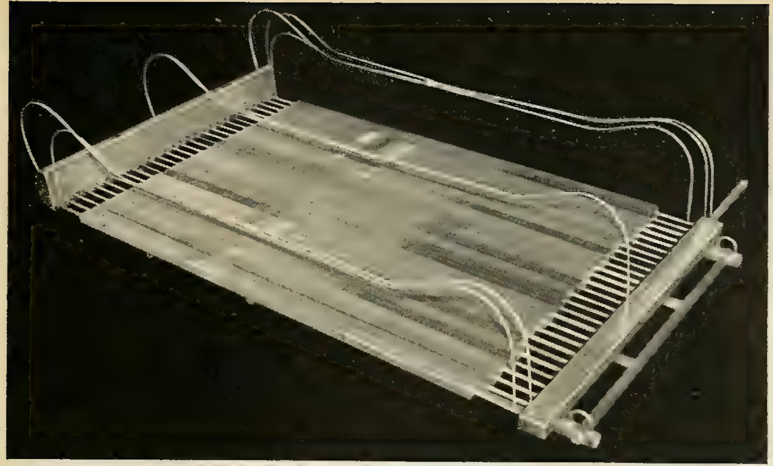
The Weather Bureau is particularly interested in getting a satellite with about three years of operational life.

The Weather Bureau was to fund three *Nimbuses*, in addition to the four R&D satellites already funded by NASA. NASA has said it will continue with its portion of the program.

Telepathy Discussed at IAC

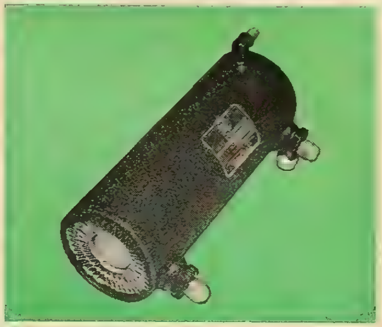
PARIS—Both Russia and the U.S. are studying the use of mental telepathy for space communications, but the Soviets—if their reported results are to be believed—will succeed first, a U.S. delegate told the 14th International Astronautical Congress.

Dr. Eugene Konecci, director of NASA's Biotechnology and Human Research and chairman of the International Astronautical Federation's Bioastronautics Committee, noted in



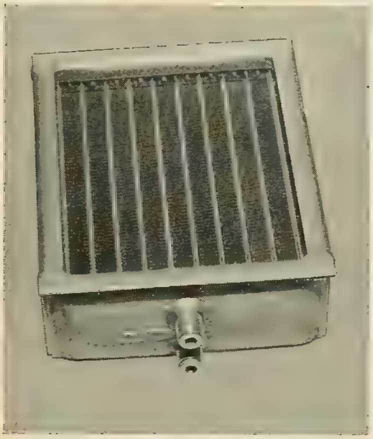
Snap 8 Mercury Condenser

IRBM Guidance Cooling, FC-75/Air

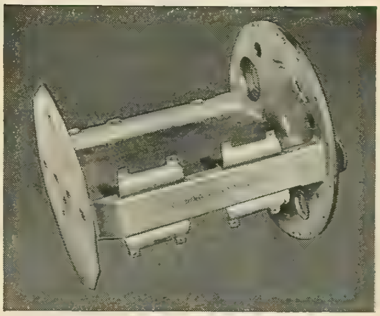


Sparrow III Electronic Guidance Cooling, OS-45/Air

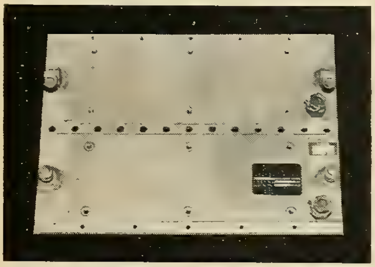
IRBM Guidance Cooler, FC-75/Air



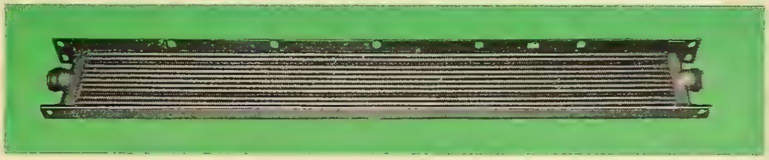
Missile Guidance Cooler, FC-75/Air



Sparrow III Cold Plate Chassis for Electronic Cooling-Air



Titan III Guidance Cold Plate, FC-75/Air



Missile Launch Vehicle Hydraulic Cooling, Air/Oil

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a paper delivered at the Congress that the Soviets had given "top priority" to what he termed "biological radio communication." He said that Western scientists had until recently almost ignored such research.

General aim of the Soviet program, Konecci said, was to enable Earth-bound humans to communicate with humans on the Moon without using electronic equipment. "If the results of conducted experiments are half as good as the Soviets claim," he added, "then they may be the first to put a human thought in orbit or achieve mind-to-mind communication with humans on the Moon."

U.S. researchers have conducted tests between two persons, one of whom was on a submarine, Konecci reported. The results have been encouraging but not conclusive.

Some 1,000 delegates from 34 nations attended the Sept. 26-Oct. 1 meeting. Soviet delegates presented 16 papers—second only to the U.S.—but these did not discuss hardware subjects or operational techniques such as orbital rendezvous.

In another portion of his paper, Konecci revealed that NASA was investigating the effects of lasers on flesh, in view of the likelihood that laser tracking will be used in connection with manned space vehicles.

Describing work under way at Westinghouse and Oklahoma University, he said a 30-joule pulse was directed at several guinea pigs, which were then examined under a dissecting microscope. They appeared to remain organically healthy, he said, although their white hair turned red at the tips and the external layer of skin apparently melted.

(*A complete report on the IAF Congress will appear in the Oct. 14 M/R.*)

Comsat Stock Offered

Communications Satellite Corp. is preparing to place its first stock offering on the market early next year.

Stock is to be issued in two series, one for common carriers and the other for the general public. Price per share is limited to $100 by Congress, and may be sold for considerably less.

Also announced by Comsat last week was the appointment of David J. Melamed as corporation secretary.

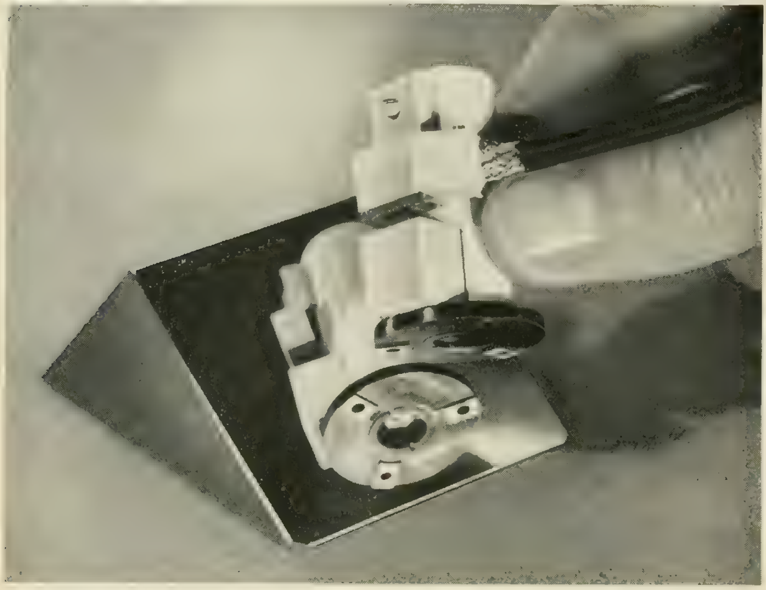
Joint NOSS Program Probable

PALO ALTO, CALIF.—NASA officials told MISSILES AND ROCKETS last week that a joint military-NASA manned space station seems to be the most likely route for a space station program, but that it is doubtful whether a decision will be made during this fiscal year.

Dr. Raymond L. Bisplinghoff, head of the Office of Advanced Research and Technology, said at the American Institute of Aeronautics and Astronautics meeting on engineering problems of manned interplanetary exploration that if there is a joint military-NASA station "I would fully expect to see a full-fledged scientist as part of the crew." Dr. George M. Low, NASA director of spacecraft and flight missions, agreed that a joint effort seemed most likely.

At the same time, NASA spokesmen expressed the view that a manned space station, rather than a manned interplanetary mission, was the next logical step because it is within present capabilities. Although most observers agree with this, there apparently remains some doubt as to which objective will get the nod first.

H. H. Koelle, director of the future projects office, Marshall Space Flight Center said that "probably within a year or so, we shall have evidence of whether a space station will be started. Probably the space station is the next objective to be formalized."



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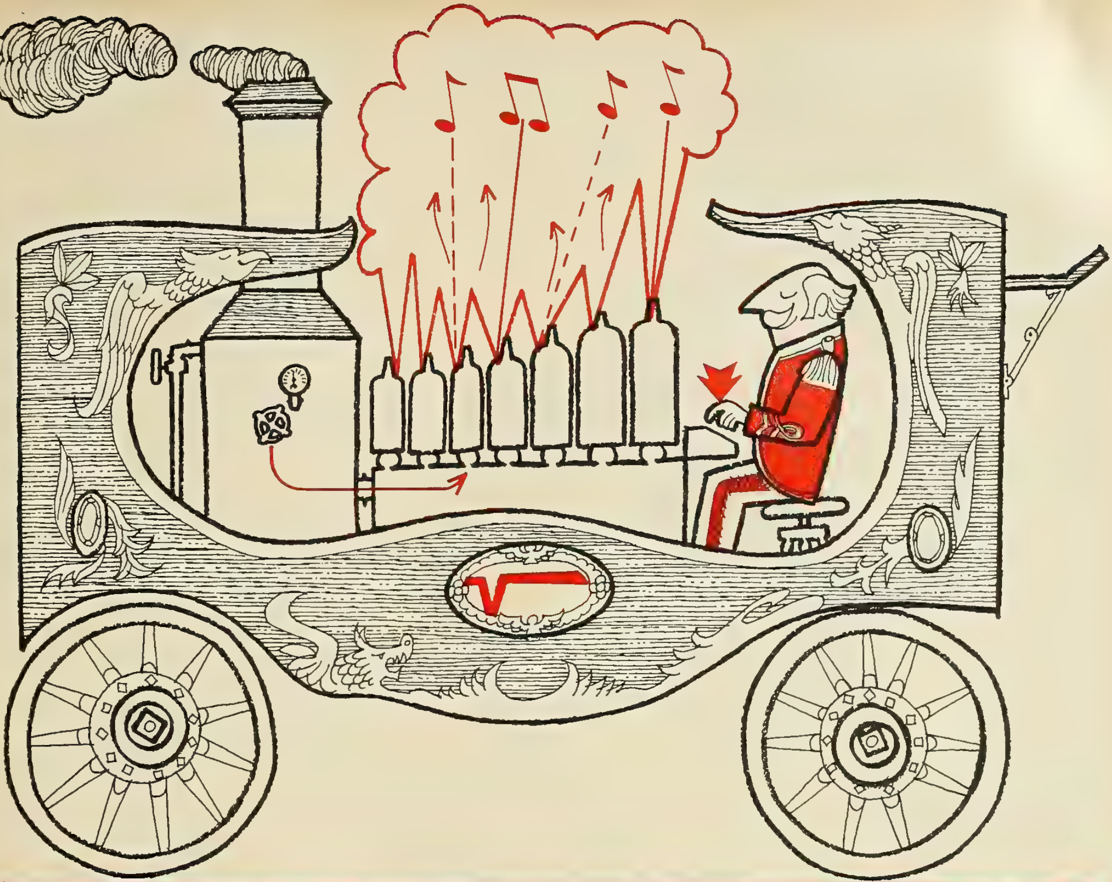

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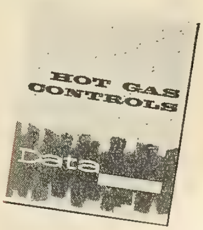

HOT GAS CONTROLS

Data

1911

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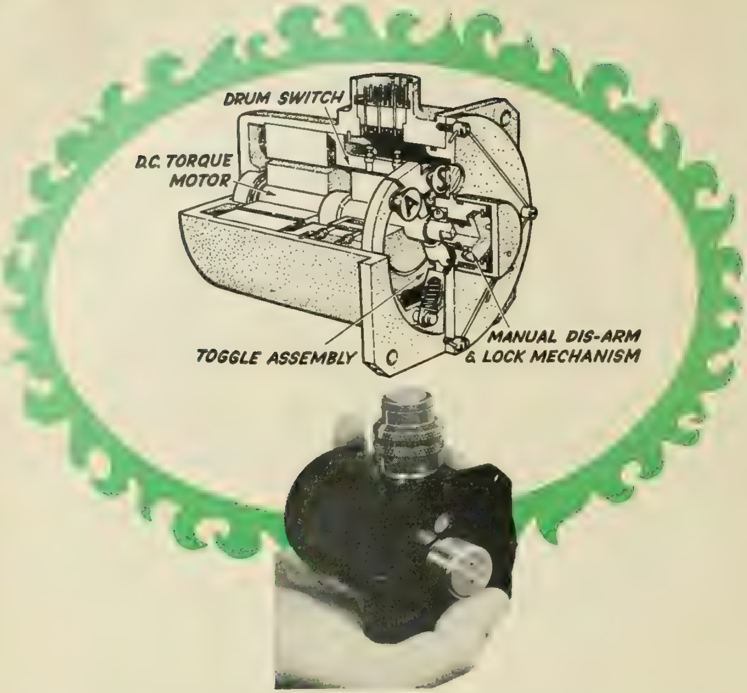

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Koelle thinks the main problem in the way of obtaining space station approval is the difficulty of listing tangible benefits. The military appears to be having similar difficulty in formulating its reasons for a space station, he said.

Koelle and Harry O. Ruppe, assistant director of NASA's future projects office, suggested that a space station could use fallout from the *Apollo* program. But Ruppe said some experts believe adaptation of an upper stage of *Saturn* for use as a space station might be so complicated that the amount of work involved might better be devoted to building a station from scratch.

- **20 years away**—Financial and technical considerations indicate that a U.S. manned planetary mission may lie 20 years or more in the future.

This estimate emerged as both NASA and industry representatives made these points:

—Resources to start "one or two" major space programs probably will not become available before FY 1967 in view of the *Apollo* commitment, Koelle reported. Available resources, more than anything else, will determine when a major effort for the manned planetary program can begin.

—Nuclear or nuclear-electric propulsion is mandatory for landing missions, unless a long trip time with chemical propulsion is tolerable, and it is too early to predict when these systems will be available. Considering this and the lead-time required to prepare for a "fast" interplanetary mission, it seems doubtful that a manned Mars landing for 1975 would be feasible, according to Koelle.

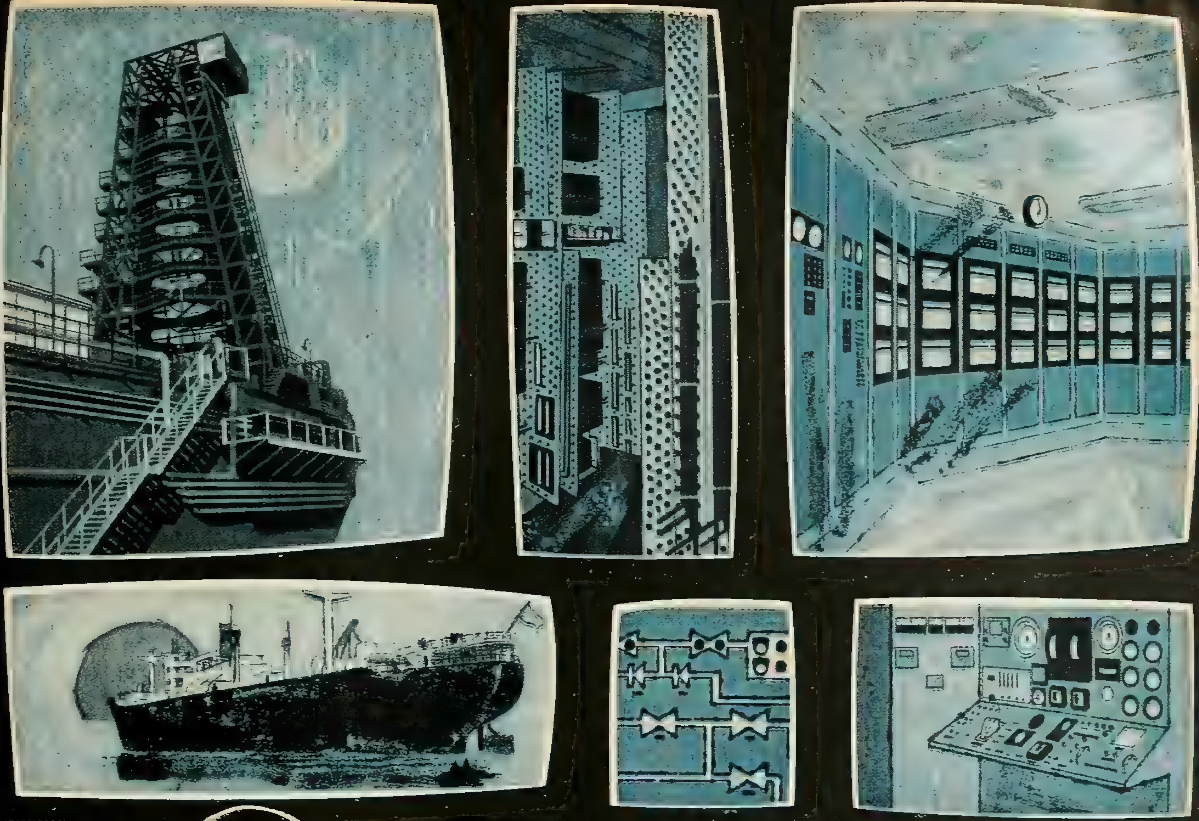
—Velocity requirements for fast Mars missions will increase rapidly in the 1975-1984 period, making landing missions both more costly and more technically difficult.

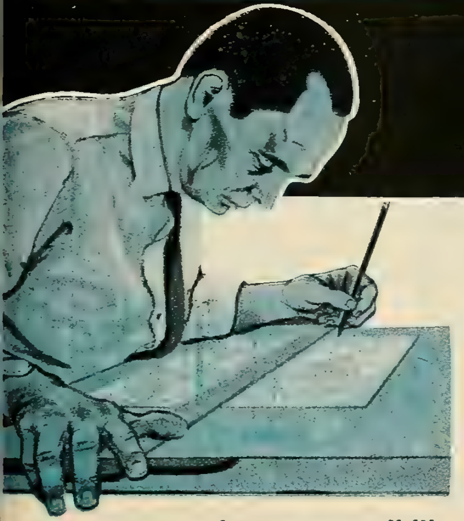
House Research Probe Set

The House Science and Astronautics Subcommittee on Science, Research and Technology will begin hearings Oct. 16 on the state of the nation's research effort.

First to give testimony will be Dr. Frederick Seitz of the National Academy of Sciences. Others in following sessions will include Drs. Edward Teller and Jerome Wiesner. Rep. Emilio Q. Daddario (D-Conn.) said the subcommittee and staff have been working out guidelines on how to approach the problem of investi-

(Continued on p. 28)





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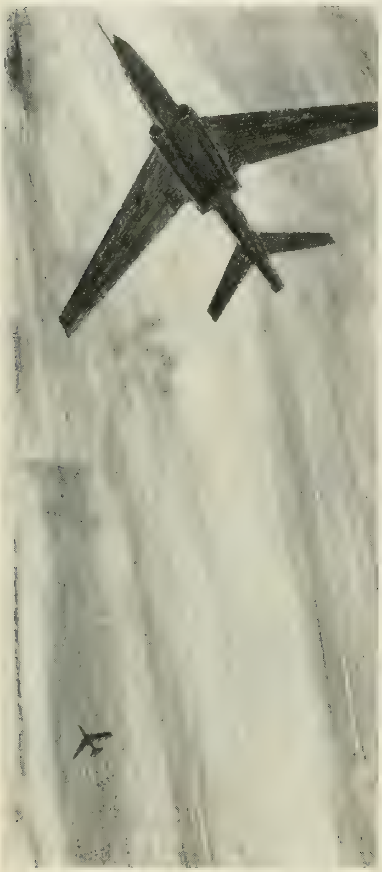
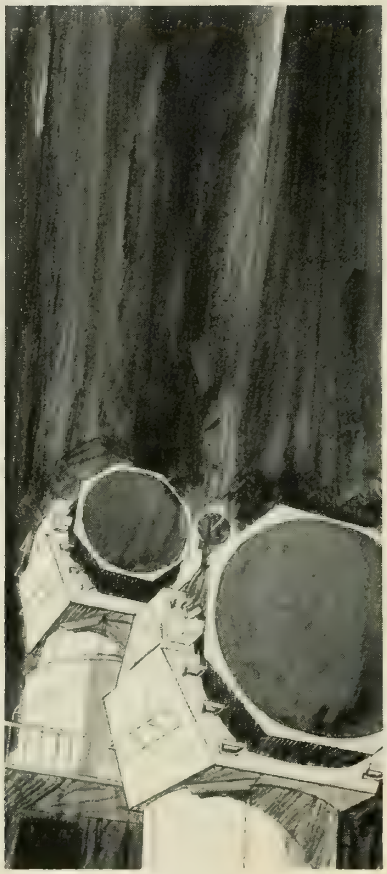
HONEYWELL ADVANCED TECHNOLOGY REPORT NO. 5

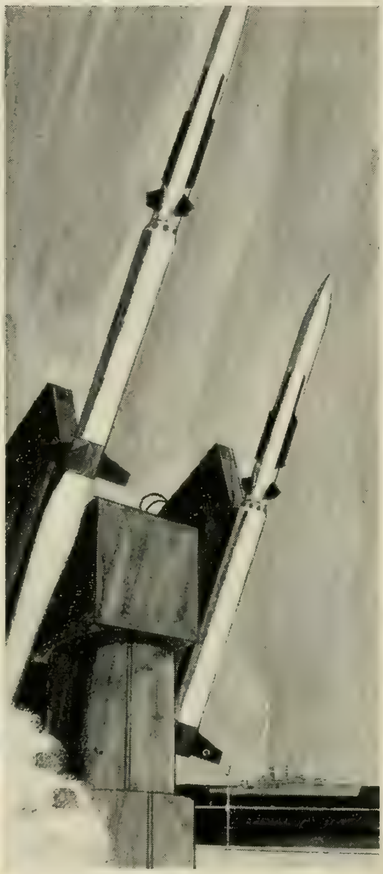
Is simulation the answer



Target tracking of aircraft by radar is simulated by Honeywell's Weapon Control System Simulator. Training includes distinguishing between friend or foe.



Director assignment is simulated so weapon control operators can be trained to select a specific target, assume the target tracking function and take action on a team basis.



Weapon assignment is performed by Weapon Control System Simulators. Firing of weapon is simulated, as well as hit or miss of target many miles away.

Trainers keep missilemen "operationally ready"

Since extensive practice firing of missiles is uneconomical, if not impracticable, the military services are now providing continuous training through the firing stages by using trainers that duplicate reactions of actual missile systems.

To train shipboard air defense teams, Honeywell has developed Weapon Control System Simulators (see illustration above) for the Fleet Anti-Air Warfare Training Center at Dam Neck, Va. They indicate action to be taken and stress teamwork among personnel in the support force.

Ground warfare missile systems are also simulated by Honeywell. Trainers for the Little John missile, for instance, realistically simulate all preparation and firing procedures—including a burst of smoke when the launch button is pushed. The missilemen must assemble a dummy warhead to the motor, mount the unit for launching and then perform all checkout functions. Little John simulators, which are reusable, also allow instructors to pre-set malfunctions so that realistic electrical checkout and fault detection can be performed.

In building trainers, all aspects of the weapons system must be known. Team relationships must be simulated so that commanders and operators can learn how to work with and direct groups of personnel and equipment. Honeywell trainers accomplish this through the company's first-hand knowledge of missiles, fuzes, warheads, pyrotechnics (fire power flash, smoke and shock), digital circuitry, communications, optics and electronics.

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to missile-age training?

New trainers offer combat "experience" at reasonable cost

How can military forces be trained in the operation of advanced weapons when each practice mission could cost millions of dollars and involve thousands of troops and several supporting forces?

The economical way is to simulate actual battlefield conditions, including weapon systems, target supporting forces and enemy maneuverings.

Training systems that do this are being produced by Honeywell for various government agencies including the Naval Training Device Center at Port Washington, N.Y. As prime contractor on a number of such systems, Honeywell has produced a variety of training devices from pop-up gunnery ranges to submarine warfare simulation systems.

Design of the most sophisticated integrated team trainers involves three major considerations: (1) Human factors, or the relationship of man to weapon in a combat situation; (2) Flexibility of operation, permitting fast reaction to changes in tactics or errors on either side; and (3) Mission, operation and environment of the weapons systems and their relationship to the overall problem.

In developing and building trainers with these considerations in mind, Honeywell applies a unique knowledge of the mission and environment of weapons acquired through *active participation in every type* of U.S. military and space program.

Honeywell is thus able to synthesize an entire weapons system—including its environment, mission and team relationship—and also simulate realistic situations for solution by trainees. This sometimes requires developments beyond the state of the art in optics, computing techniques, displays, electronic circuitry and communications.

These Honeywell training systems are often more flexible than the actual weapon system they simulate. As a result, regular training with these simulators gives combat personnel better all-around experience than does limited practice with actual weapons.

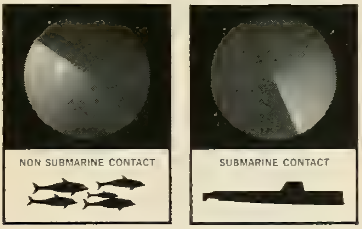
For further information on our capabilities in training and simulation, write Honeywell, Dept. 671A, Minneapolis 40, Minnesota.

Advanced optics required for trainers

A military trainer succeeds or fails on the quality of the optical image it projects for the trainee. The image must have realism and precision, yet the optical system must be simple. This calls for *advanced concepts* in optics.

For instance, one Honeywell trainer required optical mixing of models, film and television. Another demanded the development of wide angle lens systems compatible with a complex target-seeking device. Also, a Honeywell simulator included an optics system consisting of a folded path collimator which gives reconnaissance systems a realistic view of terrain transversing at sub-mach to orbital speeds.

To produce these advanced concepts in optics, Honeywell has a complete optical laboratory staffed with highly competent opticians who work with human factors and electronics engineers in developing displays, infrared and ultra violet sensors, laser devices and a wide variety of precision optics and electro optics.



Sonar developments lead to better undersea training

Sonar equipment is the most useful sensor on a submarine. However, it is difficult for operators to consistently classify sonar signals with accuracy.

In order to train teams in detection, classification and tracking, sonar echoes must be simulated with realistic signal-to-noise ratios and spectral shapes as they occur at sea.

Precise simulation of sonar target echoes is a current Honeywell-sponsored research project that will enable future sonar operators to better differentiate among various types of sonar contacts.

Honeywell's study of recorded target echoes will explore the subtle characteristics of various signals to give sonar instructors greater freedom and speed up this aspect of sonar training.

Among Honeywell-developed sonar devices is the Julie Target Simulator which produces simulated submarine target echoes for training anti-submarine aircraft crews.

Another Honeywell system trains groups of operators in the use of consoles and shipboard controls in identifying mines and other marine objects.

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gating the vast government research program. Eventually, reports and recommendations will be issued.

NASA Turns to Incentives

NASA has announced that it is ready to award its first major incentive contract and will henceforth examine all future large awards to determine if an incentive formula can be applied.

The space agency said the new incentive feature will be tried in its procurement of the *Lunar Orbiter Photo* spacecraft, for which RFP's have been issued to more than 100 firms.

The new contract will permit industry to receive higher profits through exceptional performance in cost cutting and technical performance. Conversely, it will pay a fee for cost overruns and late delivery.

Under the formula, the contractor will benefit by $1 for every $10 reduction below a set target cost and will be penalized $1 for every $10 above the target cost. Penalties for late delivery of the spacecraft could be as high as $10,000 for each day of delay. The maximum penalty, however, would be $300,000 for each spacecraft or $1 million for the five vehicles currently included in the program.

Superior technical performance will enable the contractor to earn a maximum bonus of 7% above the target cost. Because NASA wants to have a successful flight with the lunar orbiter as soon as possible, and because reliability will be harder to achieve with the first spacecraft in the series, the bonus for superior technical performance will be higher for the early spacecraft. The breakdown would allow bonuses of 2⅔% of the target cost for the first craft, 2% for the second, 1⅓% for the third, ⅔% for the fourth and ⅓% for the fifth.

Because the delivery penalty and technical performance bonus will be a matter of judgment, NASA has established a three-man board to make the determinations. It will be composed of the Director of the Office of Space Sciences, the director of the Langley Research Center and a board chairman to be named later by Associate Administrator Dr. Robert Seamans, Jr.

"This is about the first time," a NASA official said, "that we have gone to industry for a quote, saying in advance that there will be incentive features" in the resulting contract. NASA management expects its incorporation of incentive features into original proposals to discourage over-bidding on performance and delivery capability, as well as underbidding of cost—which NASA says has in the past "led to built-in performance deficiencies, schedule slippages and cost overruns."

In addition, the agency hopes the new incentives will encourage better advance planning and definition of programs, as well as "more thoughtful consideration of changes" by both NASA and the contractor. Moves to produce greater industry and government motivation toward improved performance, on-schedule deliveries and lower end-costs are also reflected in the character of the procurement.

A major distinguishing character of the *Lunar Orbiter* RFP is that it contains all the terms of the definitive contract—not only the work statement, but the specific formula for establishing ultimate profit as well. All the proposer is asked to provide is target cost, a target profit and a delivery schedule. If he does not agree with any other provision, he must propose a definitive substitute for that provision. Also, NASA encourages firms to submit, in addition to the agency-prescribed proposal, additional bids containing "any incentive formulas which they think may be better."

As a result, when NASA picks the contractor for this job, it will already have that contractor's commitment to all the terms of a definitive contract. Thus, the letter contract is eliminated and competition is retained up to the point of contract execution.

Robert H. Charles, a special assistant to NASA Administrator Webb who has worked closely on the agency's moves toward increased incentive contracting, says the inverse-proportion relation of objective targets and their incentives to the judgmental procedure is provided by NASA because it recognized that judgmental procedures are "not the most desirable form of incentive, which should be wherever possible specific and measurable objectivity." Clearcut agreements worked toward by both sides throughout the contract's execution will be encouraged by the arrangement, and "hopefully, we could eliminate the entire judgmental incentive, eventually," he said.

Other unusual features of the new RFP include NASA's use of a double closing date—Oct. 4 for technical proposals, and Oct. 14 for cost proposals on the same procurement.

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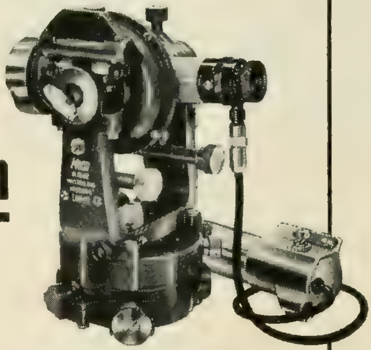

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Furthermore, NASA is now asking each bidder to quote on any possible follow-on procurement for *Lunar Orbiter*. The quotation would not be in terms of dollars (as the craft is as yet undeveloped), but rather would be expressed as a formula by which the cost of such added units might be established later on. In effect, constituting "a series of figures . . . derived from a learning curve submitted in competition and based on the last unit (provided) under the original contract," the formula will lead to figures "based on an article into which have been cranked all the developments of the original contract," NASA predicts. The agency, Charles believes, also will be able to extend healthy competition further along in the progress of a procurement effort. "If this technique is successful," Charles says, "we will be able to establish the parameters for follow-on production during competition."

Trevor Gardner Dies at 48

Trevor Gardner, chairman and president of Hycon Manufacturing Co., Monrovia, Calif., and former assistant secretary of the Air Force for R&D, recognized by many as the "father" of the U.S. ICBM, died of a heart attack at his Washington, D.C., home on Sept. 28. He was 48 years old.

When Gardner resigned from his Air Force post in 1956, after holding the assignment a little over one year, he spoke out strongly against government laxity in launching a major missile development program. Prior to his resignation, he sought unsuccessfully to persuade Charles E. Wilson, then Secretary of Defense, and Air Force Secretary Donald A. Quarles to provide more funds for ICBM development, in which he said the Soviet Union was gaining a dangerous lead.

A native of Cardiff, Wales, Gardner was general manager and executive vice president of General Tire and Rubber Co. of Calif. when only 30 years of age. He joined Hycon in 1948 and entered government service in 1953 as special assistant to the secretary of the Air Force for R&D.

In 1944 he won the Naval Ordnance Award, and in 1945 the Presidential Certificate of Merit. He served as a member of President Kennedy's space task force and of the AF space task force. At the time of his death, he was a member of the general advisory committee of the U.S. Arms Control and Disarmament Agency, the board of trustees of Aerospace Corp. and the board of visitors of AF Systems Command.

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SYSTEMS ANALYSIS ENGINEERS

Will analyze systems performance, conduct servo analysis and solve trajectory problems using analog/digital computers and construct mathematical models. Knowledge of advanced calculus, vector analysis, classical mechanics, Bode diagrams, root locus plots and LaPlace transforms highly desirable.

SYSTEMS INTEGRATION ENGINEERS

Will integrate components into the inertial guidance system and the system into the vehicle and solve problems of interface, such as grounding, signal isolation, and hardware and digital computer interface. Knowledge of inertial navigation, gyros and accelerometers is required.

Qualified Applicants are invited to visit our facilities, meet our people and discover for themselves the many added advantages of working and living here on Florida's Suncoast. A brief note, describing your education, experience and specific area of work interest, addressed to **S. M. Keese, Honeywell 13350 U. S. Highway 19, St. Petersburg, Florida,** will bring a prompt, confidential reply.

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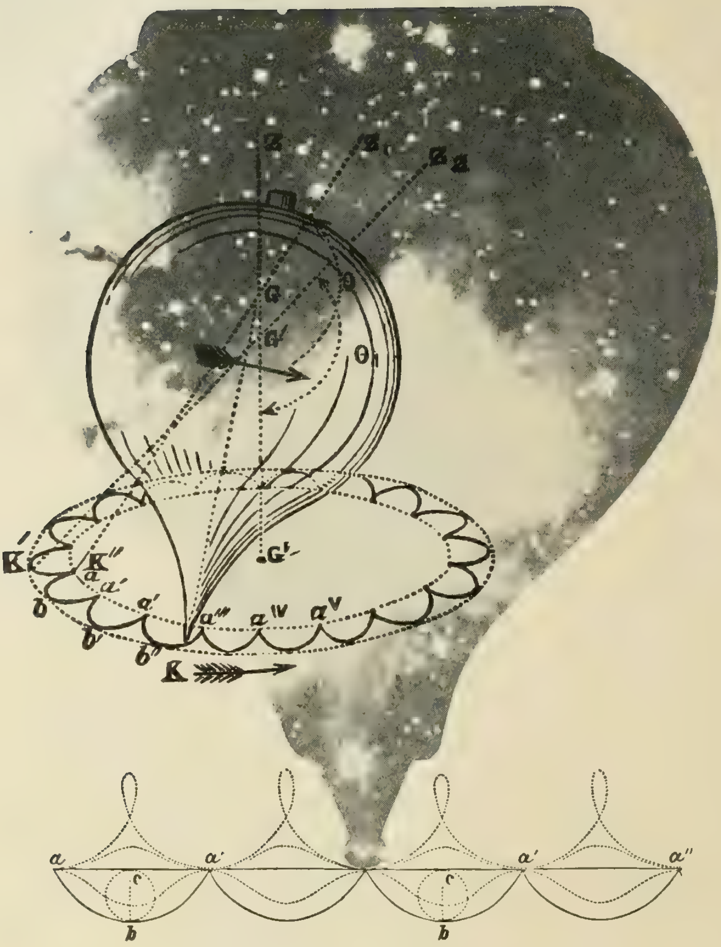

SIR JOHN HERSCHEL'S PHILOSOPHICAL INSTRUMENT

In the 19th century, Sir John Herschel experimented with tops. He called them philosophical instruments, relating their forces and movements to those of the planets. Some of his contemporaries expressed skepticism, but the observations of this noted astronomer have emerged as major contributory factors to today's advanced inertial navigation technology. ☐ Litton—largest producer of inertial navigation systems — remains mindful of Sir John's findings as it delves deeper into such space vehicle guidance problems as launch, orbital injection, satellite inspection, rendezvous missions, extended-time excursions and reentry. Now under development are advanced guidance systems for orbital and suborbital vehicles, including highly sophisticated, self-contained stellar-inertial designs. These and other space guidance concepts are being pursued with modularity, producibility and reliability as key constraints.

LITTON INDUSTRIES GUIDANCE & CONTROL SYSTEMS DIVISION

WOODLAND HILLS, CALIFORNIA SALT LAKE CITY, UTAH DULUTH, MINNESOTA BEVERLY HILLS, CALIFORNIA

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SPECIAL REPORT: GUIDANCE AND CONTROL

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Market for Balance of Decade Expected to Approach $8.8 Billion

THE GUIDANCE AND NAVIGATION market, including control electronics, for missiles and spacecraft will approach $1 billion in Fiscal Year 1964 and rise slowly to $1.4 billion by FY '70.

The total estimated expenditures in this market for the seven-year period will reach nearly $8.8 billion.

Industry market experts polled by M/R editors still predict a large future growth in guidance and control (G&C) for spacecraft, primarily military.

While non-pre-empted G&C money for FY '64 is relatively small ($210 million), the new missile/space G&C market available to industry by FY '66 should reach about $700 million—or over 55% of the total expenditures for that year.

A current trend to major system standardization could, however, have a serious effect on new markets. The Air Force approach to a standard booster G&C system and NASA's similar approach to the manned lunar vehicles program greatly restricts the field for potential suppliers. For example, IBM provides the guidance computer for *Saturn, Gemini,* and *Titan III,* as well as the *Titan II* ICBM. Furthermore, the *Apollo* G&C suppliers very probably will provide their hardware for the Lunar Excursion Module (LEM) and other subsequent landing capsules that may be employed in the future.

This procedure may reduce costs in time; however, many industry experts feel that it may be self-defeating. They claim that systems designed for a general application may often compromise overall performance.

The overall problem of determining the best G&C system for future missions is a complex undertaking in optimization in which trade-offs are difficult to evaluate. A requirement for faster response might lead to the installation of more powerful actuators and more complex control circuits, for example, and these in turn mean more weight, which slows response. Such a typical consideration is only part of the overall problem of optimizing missile design.

At present, there is a lot of discussion of optimization techniques, but no practical design methods which are ready for use. There is a definite need for such techniques, and they are being developed. At present, their effect on G&C systems cannot be predicted, but they will throw up such questions as "just how much can be paid for increased accuracy in missile systems?"

Already the costs of inertial systems are extremely high and users are questioning whether the overall economics of weapons systems merit further expenditure on increasing accuracy.

Two major trends stand out in the design and manufacture of guidance and navigation systems for both missiles and spacecraft.

- **Push for microcircuitry**—One is the increased emphasis by all services and NASA on early employment of microcircuitry in electronic subsystems. Approaches include thin-film single- and multiple-deposition techniques to provide greater functional and component integration.

The goal—more obvious than the methods for its attainment—is to improve reliability and maintainability by several orders of magnitude. Microcircuits by their nature offer promise for greatly reducing the number of interconnections in complex systems, and they are readily adaptable for automated production, assembling and testing.

Advanced Minuteman has served to open the way for fully funded R&D in this field. Also, integrated avionics in new military aircraft are expected to make broad use of such circuitry. First serious production should develop within three years.

A major deterrent to broader use of micromodules during the next several years is cost. Presently conceived modules are priced too high. Modules in the $7-to-$8-per-unit range, resulting from standardized design and automated production, will be needed.

Early systems will make use of modularized circuit replacement; ultimately complete subsystems and systems will be built.

Leaders today include Westinghouse, Texas Instruments, Signetics,

Total Estimated Guidance and Control Expenditures

(Note: totals by calendar year include RDT&E, production, spares, maintenance and retrofit, but exclude government in-house expenditures.)

AF/NAVY/ARMY/NASA

Calendar Year—In Millions

	'64	'65	'66	'67	'68	'69	'70	Total
Missiles	500	500	510	500	480	420	400	3,310
Spacecraft	470	630	710	800	920	950	1,000	5,480
Aircraft	450	450	420	400	400	390	330	2,840
TOTAL	**1,420**	**1,580**	**1,640**	**1,700**	**1,800**	**1,760**	**1,730**	**11,630**

MISSILES/SPACECRAFT/AIRCRAFT

	'64	'65	'66	'67	'68	'69	'70	Total
Air Force	800	810	820	850	920	900	910	6,010
Navy	300	390	420	450	480	470	450	2,960
Army	190	210	220	210	210	200	180	1,420
NASA	130	170	180	190	190	190	190	1,240
TOTAL	**1,420**	**1,580**	**1,640**	**1,700**	**1,800**	**1,760**	**1,730**	**11,630**

Motorola, General Electric, Fairchild Semiconductor and IBM.

A sidelight to the effort to advance in microcircuitry is the fact that every major prime and first-tier contractor is maintaining at least a modest R&D program in the field. Manufacturers have been forced into such research in self-defense: to be able to procure and use such hardware in the future, they must keep pace with the technology.

● **Digital computers**—The second major trend is the steadily increasing dependence of designers on digital flight computers.

In missiles, there has been an increasing use of digital computers—initially for navigation, later for navigation, steering computations, stability augmentation computations, instrument calibration, pre-flight checkout, in-flight performance monitoring, staging control, thrust cut-off computations, and warhead pre-arming computations.

A similar growth of digital computer application is forecast for space vehicles. Under development are digital computers capable of performing guidance, control, steering, star tracking, display and performance monitoring. The on-board computer in *Dyna-Soar*, for example, is involved in re-entry and energy management functions. In *Apollo*, the computer will be used for orbit injection computations and mid-course and terminal guidance functions. In rendezvous missions, a digital computer is incorporated in the automatic loop.

A reflection of the growth of the use of digital computers can be seen in the increase in memory storage in such missiles as *Minuteman*, where memory capacity has been doubled in improved versions of the guidance system.

A further requirement for enhanced digital computer capability will arise in G&C systems for control of entry into planetary atmospheres. Because of the high speeds involved and the variability of atmospheric parameters, adaptive control systems are likely to be used.

These systems are likely to be more ambitious than the adaptive system used in the *X-15*. Basically, they are expected to vary the gain in the control loop of the guidance and control system in accordance with the total situation in which the system is involved.

As with optimization, there has been a large amount of theoretical work published on adaptive systems, but very little has emerged by way of practical design techniques.

● **Computer capacity**—Paralleling the growing use of digital computers has been an increasing use of digital pick-offs and non-linear processing. Availability of a computer means that more complex filtering can be carried out in the control loop. For example, when multiple bending modes are present and rate gyros are being used to measure vehicle motion, the computer can be used to filter out the velocity components arising from the bending modes.

ESTIMATED EXPENDITURES BY NASA MISSION AREAS (in millions)

	'64	'65	'66	'67	'68	'69	'70	Total
Launch Vehicles	40	60	65	75	80	85	85	490
Scientific & Applications Satellites & Probes	50	60	60	60	55	55	55	395
Manned Earth Orbital & Lunar Expeditions	40	50	55	55	50	45	45	340
Interplanetary Exploration					5	5	5	15
TOTAL	**130**	**170**	**180**	**190**	**190**	**190**	**190**	**1,240**

ESTIMATES OF THE NON-PRE-EMPTED G & C DOLLARS

(new markets available to industry)

Calendar Year—In Millions

	'64	'65	'66	Total
Missiles	120	170	225	515
Space:				
Military Operations	15	70	130	215
Support	10	25	70	105
Scientific & Application	25	60	105	190
Launch Vehicles	40	125	160	325
Aircraft	40	95	195	330
TOTAL	**250**	**545**	**885**	**1,680**

Systematic non-linearities in a guidance mechanism can be compensated by a computer program, but recalibration of the mechanism must be more frequent than the rate at which changes are taking place. Future in-flight testing to check that a guidance system is functioning correctly may take the form of applying a known forcing torque to a gyro and checking its performance against a stored specification.

Computer capacity also brings the possibility of computing the location of the gyro rather than applying forcing torques to it to bring it to some specified value. Another possibility is relaxation of the machining accuracies of platform systems and compensation of alignment errors by means of a computer program.

In general, the increasing computer capacity in vehicles is causing a changeover from hardware complexity to program complexity. Primarily, the greater memory storage is of value inasmuch as it allows trajectory expansions and correction terms to be evaluated to a higher number of terms.

● **Other avenues**—At present, celestial-oriented devices on inertial platforms are being extensively studied for use on interplanetary probes. Use of the spacecraft as the inertial platform is being studied as a future possibility, while the benefits of redundancy mean that a combination of on-board inertial and ground-based tracking will be coming into use in 1970.

A star tracker is imperative for future needs and a prime requirement for it is long operational life, which rules out the use of moving parts. Present and near-future devices will be single-star devices with some form of recognition of the star. Recognition of star fields will come later.

There is a trend towards the elimination of gyros in spacecraft. In *Mariner*, for example, the rate gyros used during Sun and Earth acquisition and course correction were switched off during the cruise mode and rate information was obtained by computation for the energy expended by the cold-gas stabilizing system. In the next *Ranger* shot, gyros will not be used in the initial acquisition maneuver.

Thought is being given to the problems of pursuit and rendezvous with uncooperative satellites, and the complementary problem of evasive maneuvers to avoid rendezvous. Of possible detection systems, passive infrared systems operating in the far infrared have the advantage of low weight, but require refrigeration systems of a higher reliability than is available at present. The actual maneuvers involved will put large demands on computer capacity.

In most space probes, a very slow response can be tolerated and a probe can take half an hour to perform a guidance maneuver. In pursuit and evasive rendezvous, however, very much faster responses will be involved.

● **Long-range military systems**—U.S. intercontinental-range weapon systems now available or in advanced development will provide a strong and varied base for Free World defense. These include the already well-known *Atlas D, E* and *F* series, *Titan I* and *II* series and *Minuteman*.

All are 5,000-mi.-range or better ballistic missiles.

However, the point is near where a decision must be made as to the type of weapons that will provide a balanced force structure in the 1970-75 period.

Three early alternatives could be considered: dormant long-range ballistic missiles, long-range cruise missiles or Earth-orbital spacecraft.

It appears that the *Titan II/Advanced Minuteman* combination will be operational for a long period of time; in line with the current trend to greater weapon-system selectivity by DOD, the only follow-on now is the dormant ICBM. This is now under study with limited Air Force funding.

The guidance problems will be a key consideration, particularly with regard to the inertial elements.

Long-term inactivity can create problems in components—including gassing, mass unbalance and uncertainty of operating characteristics. Possible solutions that suggest themselves are use of all-ceramic gyros or even the use of tracking after launch to improve accuracy.

The point is that the whole problem of long-term storage must be studied before an effective and reliable dormant missile program can be initiated.

The second approach, cruise weapons, is believed due for an evaluation by the Defense Dept. within the next six months. Coinciding with this evaluation is the upcoming firing of Tory 2C.

That is the test reactor for *SLAM*, which is being designed to use a nuclear ramjet engine. Tory 2A tests at partial power were very successful, but the Tory 2C will be the first fired up for full power.

The *Low Altitude Supersonic Vehicle* prime, Ling-Temco-Vought, Inc., is currently funded at $12 million and the Air Force is seeking $15 million for FY '64.

Many experts believe the Soviet Union is developing a similar long-range cruise missile. However, if the *LASV*-Nuclear (previously called *SLAM*) were to be given a full-scale development effort, it would require four years before reaching the system flight test phase—or three years under a crash program.

The third alternative involves the use of Earth-orbital vehicles, manned controllable spacecraft or orbital space platforms. However, the DOD response to date toward such programs has been less than lukewarm.

Should such efforts be intensified, much more will be needed in the guidance area to accomplish rendezvous and docking. Sensors, orbital determination techniques, and radiation shielding must all be improved.

- **Few IRBM's**—Only three U.S. intermediate-range ballistic missiles are operational—*Mace B* and *Polaris A-1* and *A-2*. *Polaris A-3* is well along in development and the *Mobile Medium Range Ballistic Missile* (*MMRBM*) is in the early development phase.

Mace B carries an AC Spark Plug inertial guidance. *Polaris* guidance systems are all designed and developed by Massachusetts Institute of Technology. The Mk-I used in *A-1* has been reduced in size for the *A-2* missile. The Mk-II guidance system will be considerably improved over the earlier version.

G.E.-Pittsfield and Hughes are principal system contractors. Raytheon supplies computers and Honeywell is building platforms for Hughes.

The total authorized *Polaris* submarine program calls for 41 ships. Thus, at least 900 *Polaris* FBM's can be expected to be built just to supply the U.S. nuclear subs. The expected British purchase will further boost production of these missiles.

MMRBM is another story. After its recent cliff-hanging experience and subsequent resurrection to a live R&D program, few experts will even pretend to predict its future.

Key element in the program is the stellar-inertial guidance system being developed by General Precision, Inc. The program dropped from a $4-million-a-month effort to $1.25 million monthly. Total planned funding is $252 million.

One major technical hurdle to overcome in the stellar-inertial system is a requirement that it be capable of uninterrupted track through a nuclear burst environment. Reportedly, this goal has not yet been achieved.

- **Limited-range surface missiles**—Nowhere is the trend to greater selectivity more evident than with the Army's new tactical missiles.

Lance, using the new simplified inertial guidance called Automet, will replace *Lacrosse, Honest John* and possibly *Little John*. *Sergeant* is replacing the venerable *Corporal*. *Pershing* will soon take over for the *Redstone*.

Both *Sergeant* and *Pershing* employ conventional all-inertial guidance systems built by Sperry-Utah and Bendix' Eclipse Pioneer Div., respectively.

All of these new weapons feature great mobility and rapid response time. Together, the three cover the complete range from 3 to 400 n. mi.

Sergeant and *Pershing* are being purchased by West Germany. *Lance*, however, may have one drawback—cost—although it is still too soon to judge. Industry observers predict that conservative estimates of the production costs of the Automet guidance system will be of the order of $9-10-thousand each. When added to the cost of the remainder of the *Lance* weapon system, the total many times exceeds the purchase price of some of the weapons it is designed to replace.

Many feel it is difficult to justify such high costs for the short-range vehicle, especially considering the excellent record established by the Army's two unguided *"John"* rockets.

For the Air Force, only *Mace A* remains, since *Matador* is being phased out. The 600-mi.-range missile employs Goodyear's map-matching guidance.

And the Navy will soon phase out *Regulus*. Sperry-Rand supplies the all-inertial guidance for this 600-mi., surface-to-surface missile. (*Talos* is the only other Navy shore-bombardment missile, but the system is limited to about 65 n. mi. and was designed primarily as an air-defense weapon.)

- **Surface-to-air missiles**—*Hawk* and *Hercules* live on with little change, except that both will get improved radars and are now being touted as anti-missile systems as well as antiaircraft defense weapons.

Hawk semiactive radar guidance is built by Raytheon, *Hercules* radio command by Western Electric. Both have found broad deployment and a foreign market.

Mauler's mobility and its apparently successful guidance system (radar track with IR terminal homing) should assure a large potential for the guidance suppliers—Hughes, de Havilland of Canada and Raytheon. The Navy has indicated a desire to obtain a *Sea Mauler* version for its small craft; NATO is believed to be interested in both systems, and from the size of its FY '64 funding (over $83 million), the U.S. Army is happy with it.

The Navy's terrible T's—*Terrier, Tartar* and *Talos*—are putting up a stout defense against their scheduled replacement, *Typhon*.

Typhon guidance, employing a phased-array radar for fire direction and control, is under development by Westinghouse. Originally, two versions were planned: a medium-range vehicle to replace *Terrier* and *Tartar* and a long-range system to replace *Talos* as an air defense system.

Talos, however, is highly regarded by the Navy and the long-range *Typhon* has been cancelled, as least for the present.

Terrier and *Tartar* also have strong DOD proponents, and it has been indicated that *Typhon* will have to clearly prove itself before it will be considered for deployment. At present, *Typhon's* developmental weapons-direction and radar system may prove to be the weak link and contribute to an early demise of the program.

- **AICBM market strange**—The anti-ICBM field represents a most unusual market. It has never produced even a near-operational weapon system, yet the market continues to grow and R&D work has been increased. Despite this, those controlling the purse strings indicate an operational system may never come to fruition.

But the strangest part of this long-sought weapon system's erratic life is that while guidance limitations have always been the cause for opposition to *Nike-Zeus,* the new low-intercept *Sprint/Nike-X* approach hardly lessens the guidance problem.

Western Electric (and Bell Telephone Laboratories) are responsible for the radio-command guidance development of both *Sprint* and *Zeus.*

Under the original *Zeus* concept, four radars were to be employed for acquisition, discrimination, target track and missile track.

Under the *Nike-X* concept, two missiles could be deployed using a single Multifunction Array Radar. *Zeus* will be used for intercept near the region of warhead re-entry—that is, above the Earth's heavy atmosphere.

Sprint, the new vehicle, will be capable of extremely high accelerations and perform the intercept at low altitude. Thus, while *Zeus'* problem really centered on the problem of discrimination, *Sprint* must have a guidance system capable of surviving and operating in a very-high-g environment, must initiate response to ground control rapidly and reliably, and must depend for its commands on a ground radar that employs highly sophisticated electronic techniques never before attempted.

- **ASM needs change**—Recent Russian advances in ground defense systems, such as the *SA-2* and *SA-3,* have extended the effective defense range out beyond 20 mi. This means that G&C systems for air-to-surface missiles (ASM's) will have to be able to bring the missile in on target from beyond this perimeter. Both the Navy and Air Force are looking at the requirements for this new generations of ASM's for use in the 1970's. The anti-radiation missile (*ARM*), *Shrike,* and *Condor* are examples of these new ground-defense destroyers.

Guidance and control for this new generation will go far beyond that used in present missile systems. *ARM,* for instance, will require radiation (or radar) seekers, combined, possibly, with inertial-guidance equipment. An IG system for such a missile must be reasonably accurate, inexpensive and small. New systems—particle reference, for instance—might well answer this requirement.

Another approach is a guidance system based on photo reconnaissance in which the missile is given a picture, or "pattern," of the target and guided to the general area by IG. There it searches until it recognizes the proper pattern and homes in on it. Martin-Orlando has developed a so-called "area tracker" which, it says, points towards the practicality of this concept.

Television and data display systems are also under consideration as missile-borne guidance equipment. Such systems would effectively extend the present *Bullpup* type of guidance, so that the pilot could visually guide his missile onto target from a much greater and safer distance.

Other areas offering promise include high-resolution radar. Here considerable progress has already been made, but much work still must be done.

Forward illumination techniques also offer promise. Here, the laser will no doubt find application. Considerable laser work is in progress throughout the nation, and progress in laser illuminators already indicates their high potential.

Most systems for long-range ASM guidance and control probably will evolve as a combination of two or more different approaches. All show promise to one degree or another, and judicious combination could well provide the most effective system for each particular mission.

Principal guidance contractors today for air-to-surface missiles include: Autonetics (*Hound Dog,* all-inertial), Martin with Maxson Electronics as second source (*Bullpups A* and *B,* radio com-

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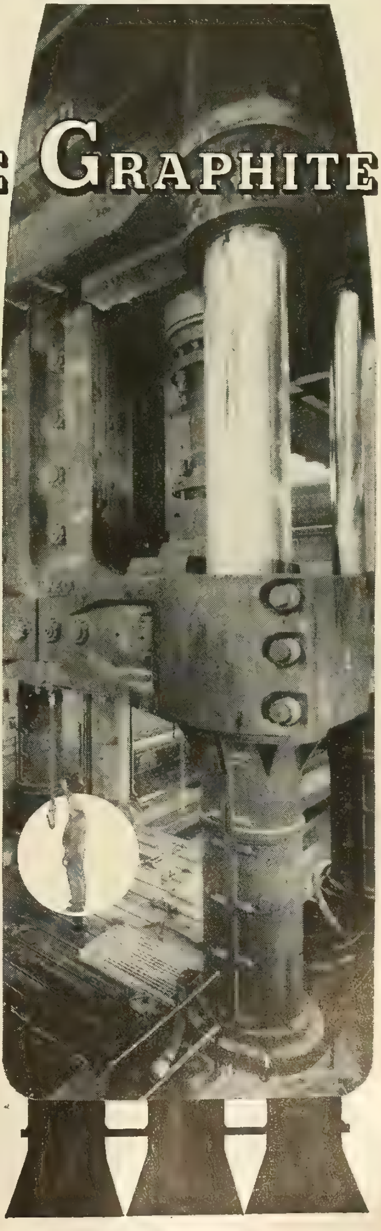


mand/visual reference), Texas Instruments (*Shrike,* passive rf homing), Naval Ordnance Test Station (NOTS)-China Lake (*Walleye,* guidance classified; *Shrike*).

- **Infrared systems**—Infrared missile guidance systems continue to constitute a flourishing market because of the large number of units involved. The market is speculative, because of the small number of different products. However, it is believed to be the biggest single military market in missile-borne guidance systems.

R&D in this field probably will expand, because the main competitor, radar, is well developed and offers well-known weight-power performance limitations. IR offers promise of a big improvement in weight-performance characteristics, but this has not yet been achieved. Proponents still forecast that IR, in a few years, will give radar a real run for even more of the market.

IR-homing missiles now in development or in production include *Falcon AIM-4, AIM-26* and *AIM-47* (both hybrid IR/radar), *Sidewinder AIM-9* and *Sidewinder-C* (the latter employs an interchangeable radar head), *Redeye* and *Mauler* (terminal homing). Principal contractors are Hughes, GE, Philco, General Dynamics and de Havilland of Canada.

Typical of the production quantities involved with the short-range missiles is *Falcon.* During the current year, infrared equipment represents about 15 to 20% of the total income of Hughes Aerospace group. About 35,000 *Falcon* air-to-air missiles have been sold, according to industry estimates.

One unknown in this field is the new *Phoenix AIM-54* under development by Hughes for the Navy version of TFX (F-111B). However, Hughes guidance is expected to be of the hybrid IR/radar type.

- **Other air-launched systems**—Air-to-air missiles not covered above (under IR systems) include *Falcon AIM-4, Sidewinder-C* (both active radar-homing) and *Sparrow III, IIIA* and *IIIB* (semi-active CW homing). Guidance contractors respectively are Hughes, Motorola and Raytheon.

Both *Falcon* and *Sparrow* have enjoyed continuous production and model improvements for years; they have been excellent investments for the two primes, who in each case also build the guidance.

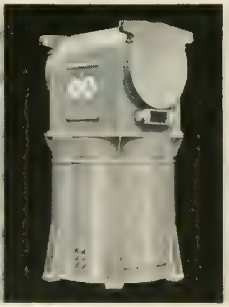
Motorola is in a different situation. The highly advanced radar guidance system it is developing under the direction of NOTS-China Lake has remained in development for nearly four years. It appears that it is being designed to oblivion. NOTS is reported to be the source of the unending modifications.

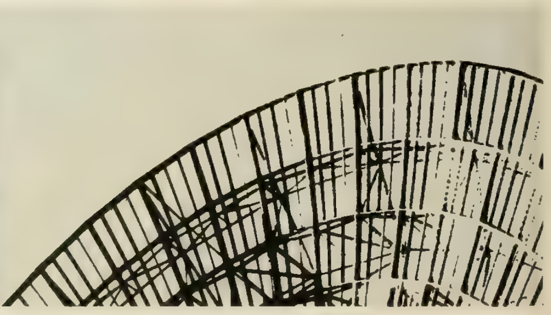
- **Wire guidance grows**—Simplest of all guidance systems currently in use —wire—by its nature limits performance. The technique, used very successfully first with *SS-10* and *-11* and later with *Entac, Astor* and *TOW,* has earned its place in weapon systems applications chiefly by its low cost, reliability and simplicity of operation.

In field use, however, such systems depend largely on the skill of the operator and a terrain free of physical impedance. *Astor* is an exception because, as an ASW weapon, it operates in an obstruction-free environment and is provided with an electronic fire-control system in the launching submarine. It has a comparatively much greater operating range (up to 11 n. mi.), but its performance has never been revealed.

Another unknown is *TOW.* After field-testing it, the Army considered it effective enough so that its development should be continued along with that of *Shillelagh,* its principal competitor.

SS-10, -11 and *Entac* guidance systems are built by the vehicle manufacturers, Nord Aviation and GE (*SS-10* U.S. licensee). *TOW* is a Hughes development, and *Astor* guidance is by Westinghouse, prime contractor for the Mk 45 torpedo, as well as the complete system. ■





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Defense Developments Put New Stress on Selectivity, Mobility

DEFENSE DEPT. and the military services are applying more and more stringent standards to their guidance and control programs. There is an inevitable trend toward more selectivity among weapon systems, and a growing insistence on high mobility.

The technical editors of MISSILES AND ROCKETS *present below a report on developments in the most advanced of the military missile and space vehicle systems.*

Advanced Polaris

DESIGN CHANGES, some new and some evolutionary, in advanced (*A3*) *Polaris* inertial guidance have yielded a system ⅓ the size and weight of its predecessor and capable of delivering the same payload with the same accuracy over twice the range.

Mk II guidance for the *A3* 2,500-mi.-range version of *Polaris* (also capable of use with the *A2*) went into development late in 1960, during the time when Mk I systems for the *A1* (1,200-1,500-mi.-range) *Polaris* were already in production. The new system had to be smaller, lighter, more accurate (over the longer range), and capable of operating in a more severe environment.

The best way to achieve this, the Navy's Special Projects Office (SPO), decided, was to concentrate on shrinking the size of the inertial system's inner gimbal, upon which the inertial elements were mounted, mainly by reducing the size of the components.

The Mk I system included three MIT-designed size "25" (2.5-in.-dia.) IRIG (Inertial Reference Integrating Gyros) stabilization gyros, and three size 25 Pendulous Integrating Gyro Accelerometers (PIGA's) mounted on the inner (azimuth) gimbal.

The Mk II system utilizes gyros of the same size, although their performance has been improved and their orientation in the system has been optimized to reduce acceleration sensitivities affecting gyro drift terms. Improved orientation also helped cut system size.

In lieu of the three size 25 PIGA's, the Mk II system uses one size 16 (1.6-in.-dia.) PIGA and two new MIT-developed size 16 PIPA's (Pulsed Integrating Pendulum Accelerometers).

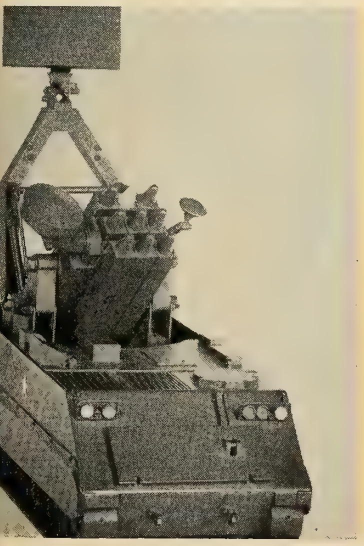
The gyro element of the PIGA uses a new electromagnetic pick-off device, called a "ducosyn," which essentially performs dual functions (gyro suspension plus signal generation or gyro suspension plus torque generation) previously accomplished by two separate devices.

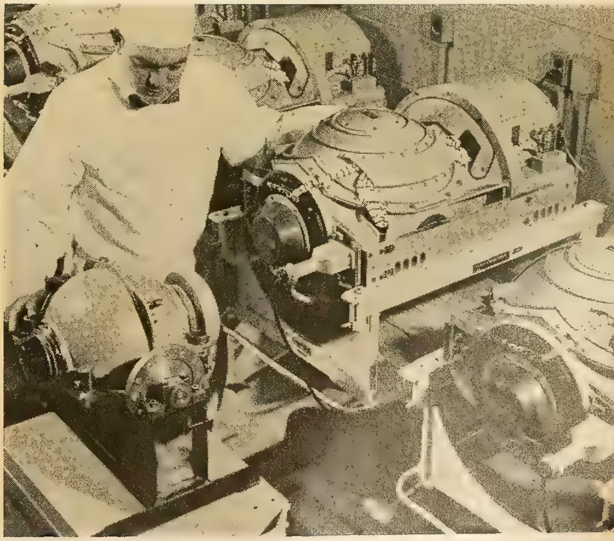
The Mod 2 IRIG's used in the Mk II system are single-axis, floated devices, using spherical floats and magnetic suspension techniques. Beryllium is the principal structural material. The gyros are virtually identical to those used in *Apollo* guidance.

Other changes also led to improved performance. For example, according to Navy officers, the Mk II system became the first ballistic missile guidance system to use lightweight, hydroformed spherical gimbals for the middle and outer units, eliminating continued use of heavier, casted units on all but the inner gimbal.

A new pancake-type resolver-torque motor was also developed to complement the spherical gimbals.

- **Two-part advantages**—The Mk II system actually is made up of two major assemblies—the gimbal assembly





LEFT: A 1/16-scale model of the Mauler system shows antenna arrangements. RIGHT: Polaris Mk II (left) and Mk I guidance systems side-by-side in GE's Pittsfield, Mass., plant. Only Mk II gimbal portion is shown in comparison with entire Mk I package. GME can also be seen on Mk II assembly.

PROTOTYPE antenna and RF processing subsystem for Navy's Shrike anti-radiation missile. Unit was developed by Radiation Systems Inc.

and the electronic assembly. The fact that the two portions can be physically separated greatly improves logistics and spare part supervision aboard an operating submarine. In addition, it makes it possible to pull only half of the system for repair.

There is another extremely sound concept behind this type of arrangement, relating to production of entire guidance systems. If the incidence of failures is found to be higher in the electronics than in the gimbal package, only additional electronic assemblies—rather than complete gimbal-electronic systems—are produced.

On-board maintenance is also a factor in design of the gimbal assembly. In addition to the spherical stable platform housing, the gimbal unit is configured with end caps (which can be seen in the photo) one of which is actually a gimbal mounted electronics (GME) package. This unit contains all the associated gyro electronics and biasing adjustments, so that there is no need to go into the "guts" of the gimbal system to make a repair or adjustment. This sharply reduces the possibility of disturbing alignment aboard ship, where there is no clean room.

- **Electronics**—The Mk II electronic assembly contains the on-board digital computer and an analog portion which contains amplifiers, converters, gimbal servo modules, PIGA servo modules, PIPA excitation devices, and power supplies.

The digital computer, being developed by Raytheon, is about "attaché case size." It uses all-solid-state circuit design, the high-density welded-stick packaging that had already won praise in *Polaris* application, and wire-wrap techniques for intermodule connection in the computer.

The device has 13 modules, or small removable panels—eight for logic functions, two for memory, and one each for memory driver functions, clock functions, and interface requirements.

The computer supplies guidance error signals to the *Polaris* flight control system. The *A3* is controlled by rotating engine nozzles on the first stage and fluid injection on the second stage.

- **Pioneering program**—Management of the entire *Polaris* program has earned many well-deserved plaudits since information about the system's success was first made public.

The high degree of management control and innovation which has characterized the entire program is very obvious on the guidance level. In many respects, management of *Polaris* guidance development might be considered state of the art in this area.

The major industrial support contractor, manufacturing the Mk II system for the Navy, is General Electric Co.'s Ordnance Dept. at Pittsfield, Mass. Hughes Aircraft Co., in El Segundo, Calif., has been brought in as a second source on the Mk II systems. Hughes, together with Raytheon Co., also serves as a second source on the Mk II electronics and computer.

AC Spark Plug Div. of General Motors, Nortronics Div. of Northrop Corp., and Minneapolis-Honeywell's St. Petersburg Div. all supply the Mod 2 stabilization gyros. AC Spark and Honeywell also supply the PIGA's, and Sperry Gyroscope Co. and Honeywell supply the PIPA's.

Bringing in second (and in some cases third) sources has yielded major economies.

In about one year's time, Navy reports, Mk I guidance system weight was cut from 312 to about 225 lbs. ■

Navy's Advanced Short-Range Systems

EXCEPTING *POLARIS*, the Navy remains extraordinarily quiet when questioned about its advanced short-range weapon systems. These include *Typhon*, *Shrike*, *Sidewinder C* and *Subroc*.

The first three of these may be having development problems, which could explain the Navy's desire to plead "security reasons" as an explanation for its total silence.

Typhon, a system originally being developed to replace *Talos*, *Tartar* and *Terrier*, embodied a medium- and a long-range vehicle configuration for fleet air defense. It's reported that the long-range vehicle development effort has been cancelled.

Westinghouse Electric Corp. is responsible for development of the weapon direction and fire-control system, which essentially represents guidance in these radio-directed vehicles. The design burden has been centered on a highly advanced, very small, phased-array radar system.

Although the system prototype, recently installed aboard the U.S.S. Norton Sound for testing, has been described as the largest single equipment ever loaded on a U.S. Navy vessel, it's reported that it will actually provide a total size/weight savings—because of its multi-weapons launch and control capability.

Typhon is believed to be suffering from R&D cost difficulties.

Sidewinder C, industry observers report, is afflicted with "perfectionitis." The *C* version of the reasonably successful *Sidewinder* air-to-air infrared-homing missile is being designed for longer range and for replaceable guidance sections—IR and radar.

Trouble seems to have developed in an attempt at the Naval Ordnance Test Station to develop a perfect radar-homing device. Motorola's Military Electronics Division in Arizona is actually building the hardware under NOTS direction.

For over 12 months, said one observer, the radar package has undergone continual modification. The end result, he said, may be that the final system—if there ever is one—will be of such exquisite design and outstanding performance that no one can afford to buy it in quantity.

Subroc represents a sophisticated nuclear/conventional depth charge delivery system. Under final development for the Navy by prime contractor Goodyear Aircraft Corp., the submarine-launched system relies on complicated guidance and fire-control subsystems built by the Aerospace and Librascope Divisions of General Precisions, Inc., respectively.

The fire-control system obtains its initial and updating information from long-range sonar, computes launcher and target position heading and speed, and directs guidance information to the weapons system.

On launch, the vehicle is driven out of a torpedo tube before underwater ignition; the inertial guidance system takes over, directs the missile to the correct azimuth and launch angle, and then cuts off thrust and effects payload separation. From that point on, the explosive element functions much as any depth charge, being activated by a preset depth.

First checkout of the guidance system under operational conditions was to have been accomplished abroad the ill-fated submarine Thresher. The loss of that craft has delayed further testing, since several of the supporting electronic systems installed were one-of-a-kind at that time.

• **Shrike too limited?**—The Navy's *Shrike* anti-radiation missile now has a somewhat confused future—largely because of limited guidance capabilities and range.

The present system was developed by NOTS China Lake and Texas Instruments, Inc. The air-to-ground weapon employs only an RF terminal homing guidance system. It does not use an inertial reference. TI built an S-band radar homer; NOTS is working on a comparable C-band subsystem.

A key element of the prototype guidance is a single four-arm spiral antenna. It functions essentially as a two-channel monopulse system to obtain two-dimensional tracking data. The antenna and RF processing components were developed for TI by Radiation Systems, Inc.

It's reported that the Navy now looks on the present *Shrike* vehicle as an interim system for several reasons: range is too short (25 mi.), the RF acquisition window is too narrow (4 degrees), and the kill radius is too small (50 ft). There is also a possibility (not yet proven) that the present guidance tracker could be jammed or confused electronically.

A more advanced follow-on is now in development at the Naval Ordnance Laboratory-Corona. Radiation Systems, Inc., is believed developing a combined broadband antenna for an enhanced guidance system under an NOL contract.

Until recently (at least publicly), the Air Force planned on purchasing the *Shrike* weapon system when it reached the production phase.

Now Air Force officials are quietly expressing their disenchantment with the Navy system. Air Force now apparently would like to develop its own ARM system for Strategic Air Command and Tactical Air Command, to meet their particular needs.

TAC, said one informant, wants longer effective range, with a more sophisticated guidance system. SAC has suggested the possibility of employing a different version as a piggyback ARM with long-range ballistic missiles for release after re-entry.

Officials of the Air Force's Aeronautical Systems Division at Wright-Patterson AFB are currently talking with potential contractors. An Air Force ARM, it is believed, would probably include an inertial reference, multi-frequency homing and a higher-thrust capability than the relatively low-acceleration *Shrike*.

Both Martin-Orlando and North American Aviation are believed to have designs for such a vehicle, and have already performed much of the initial R&D. Ling-Temco-Vought, Inc., is similarly situated for a longer-range vehicle, as a result of its earlier work on the defunct *Corvus* missile. McDonnell Aircraft is a late starter, but is believed to be rapidly assembling the background and possible suppliers for such a program, should it come to pass.

• **Guidance problems**—Judging by its general appearance and size, *Shrike* probably is a 2,000-mph weapon.

An indication of the problems facing the guidance system designers can be gained by examining what happens when a missile of this type is fired.

First, the *Shrike* must acquire a radar signal before the radar unit acquires the *Shrike*-carrying aircraft.

This suggests that the aircraft will fly in toward the coast below radar cover (below about 500 ft.) and release the *Shrike* when about 20 mi. from the onshore defense installations.

At this time both the aircraft and the *Shrike* should still be below radar cover. To acquire a radar signal, therefore, the missile must be programmed to make a steep climb into the hostile radar beam.

A steep arcing curve of this type was displayed by a *Shrike* missile in a demonstration firing earlier this year before President Kennedy.

The first radar that the missile will have the opportunity to acquire will be a sky-sweeping surveillance system. Shortly afterwards the missile may be acquired by a tracking radar. If it is, the guidance problem is simplified.

Decision on whether to acquire *Shrike* by a tracking radar will rest with a radar operator, assisted by a target evaluation computer. If his missile defense system can engage missiles of *Shrike's* speed, the operator will track and destroy the *Shrike*. If it cannot, then he will not waste his time allocating a tracking radar to the *Shrike*.

This leaves the surveillance radar for *Shrike* to home on, assuming that the target evaluation computer does not automatically re-allocate the surveillance function.

The sort of signal that *Shrike* must home on, therefore, is a narrow sky-sweeping beam. That is, the signal will be detectable for a period that may vary from about one millisecond every second up to 30 milliseconds every 10 seconds.

During this period it will receive a number of pulses with a basic frequency somewhere between 500 and 20,000 mc.

The missile is fin-stabilized but the roll period will be long compared with the signal-measuring period. That is, the roll motion would not provide a suitable scanning motion for a fixed antenna carried in the missile.

• **Accuracy demands**—Bearing accuracy requirements placed on the antenna system are apparent when one considers the final stages of missile flight.

If the missile is flying at 3,000 ft./sec. and receives its last heading information at 1 second before impact (due to the surveillance radar scanning motion), it will impact 35 ft. away from the target if the heading error is about one degree. Since other system errors will also be present, the antenna should be able to measure signal bearing to better than one degree.

The flight time for the *Shrike* at the suggested speed over a range of 25 miles would be over 35 sec. If the surveillance radar it was homing on was switched off ten seconds after the *Shrike* was fired, the *Shrike* could land as much as 280 ft. off target.

For a weapon of this type, quantity is essential. Attack on a heavily de-

Motion study. Induced rotation of a Manned Orbital Research Laboratory under study by NASA, which would provide artificial gravity for its crew, could also introduce unwelcome twist, tumble, spin and wobble in space. □ Because these motions can best be arrested by precision stabilization, Sperry is under contract to NASA Langley Research Center (1) to make dynamic analyses of the types of motion which may be encountered; (2) to derive control laws which may be applied to the resultant problems; (3) to generate control concepts which will guarantee station stability. □ Because orbital times up to a year are under study, a manned station presents a unique challenge in control. Sperry experience in gyroscopics, aerospace control, undersea stabilization logically suits us for the task. General Offices: Great Neck, New York.

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fended installation by one *Shrike* missile might not be effective; but repetitive attacks with salvos of missiles could be very effective.

Texas Instruments has received two contracts for *Shrikes*—a $1.57-million award for engineering and manufacturing services, and $1.8 million for continued R&D. ■

133B Minuteman

CHANGES IN FLIGHT computer design and inertial componentry will be major contributors to the performance gains expected of the *Improved Minuteman* (Type 133B) ballistic missile system.

Prime contractor to the Air Force for the guidance systems of both the earlier *Minuteman* (Type 133A) and the advanced system is Autonetics, a division of North American Aviation.

For *Improved Minuteman*, the company has signed an incentive contract calling for improvements in accuracy, reliability and survivability. The contract also demands reductions in cost, in-flight weight, and amount of ground-support equipment.

At present, the solid-fuel *Minuteman* is usually credited with a central error probability (CEP) of better than one mile. This suggests that the CEP is in the region of 0.8 mile. Presumably, accuracy must be improved by 10 to 20%, if the improvement is to be significant.

- **Modifications**—Main change in the guidance of the *Improved Minuteman* is use of an integrated-circuit digital computer with more than double the memory capacity of the earlier computer.

Use of integrated circuits reduces weight and promises a large increase in reliability.

Availability of increased memory capacity means greater accuracy through the use of more refined trajectory computations.

Weight reduction achieved by the use of integrated circuits will extend the missile's range. Each pound of weight saved in the final stage represents a range increase of 4.5 miles.

In the inertial measuring unit, the Autonetics velocity meters used in the Type 133A have been replaced with MIT pendulous gyro integrating accelerometers (PIGA 16G), for increased accuracy.

Control of thrust vector in the first and third stages of the *Improved Minuteman* continues to be by means of four gimballed nozzles. However, the second stage differs in this respect from Type 133A. It has a single nozzle that incorporates liquid-injection thrust-vectoring control, using freon. This arrangement takes up less space and allows a greater amount of propellant to be carried.

Nozzle position or injector opening is controlled by an electrohydraulic system. The command signal to this system is a dc voltage obtained from the computer by means of a solid-state digital-to-analog converter.

- **Single computer**—Flight control and guidance are merged into a single computer program. Data for flight control—velocity, angular altitude and angular attitude rate—are obtained from the gyros and accelerometers in the IMU.

The three-gimbal inertial platform carries two Autonetics G6B4 two-degrees-of-freedom inertial gyros and three accelerometers. Digital pickoffs measure roll, pitch and yaw. Gyro torquing is carried out by means of dc servo motors.

As the digital flight-control system provides increased accuracy over an analog system, higher gain and stability margins are achieved. The gain in the control loop is sufficient to ensure that the transfer function of the flight control system is determined by the filter (computer) and not by the characteristics of the electrohydraulic system.

The digital computer (Type D37B) is a serial binary machine with a stored program. Logic organization in the Type 133B is much the same as in the Type 133A. NAND gates implemented with diode transistor logic have been selected as the primary integrated circuit element.

Hermetically sealed in an aluminum chassis, the computer has overall dimensions of 20.5 in. x 10.3 in. x 5.8 in. It weighs 36.5 lb.

The machine is made up of three main sub-assemblies: logic, memory and power supply. The entire package is sealed and force-liquid cooled. Total integrated circuit complement of the computer is 1,908.

The computer memory is carried on a 6,000-rpm, 5-in.-dia. magnetic disc that stores 6,966 words of 24 bits each. Both sides of the disc are used for storage. Air bearings support the disc from each side. A synchronous motor powered from a three-phase 400-cps supply provides the drive.

As well as carrying out in-flight guidance and control computations, the computer provides staging control, ignition, and thrust cut-off functions. In the Type 133A, ignition was controlled by a separate device. ■

MMRBM-STINGS Program

DEVELOPMENT OF STINGS (stellar-inertial guidance systems) for military missile systems retains priority at the Air Force and DOD even though these highly promising techniques had the misfortune to be associated with two programs which have either been killed or are facing budget uncertainties —*Skybolt* and *Mobile Medium Range Ballistic Missile* (*MMRBM*).

Use of stellar sightings (probably using single tracker with two-star capability) to correct for dynamically-induced errors in a missile's inertial measurement unit (IMU) is thought to have considerable merit in terms of increased accuracy and flexibility, and decreased weight and cost.

The technique reflects the striving for self-contained missile guidance systems which can operate independently of ground control, yet are sophisticated enough to make stellar-derived corrections to the IMU before burnout to correct trajectories. A long-term effort has been made to develop the on-board optics required, and there have been rapid advances in capabilities and packaging of airborne digital computers.

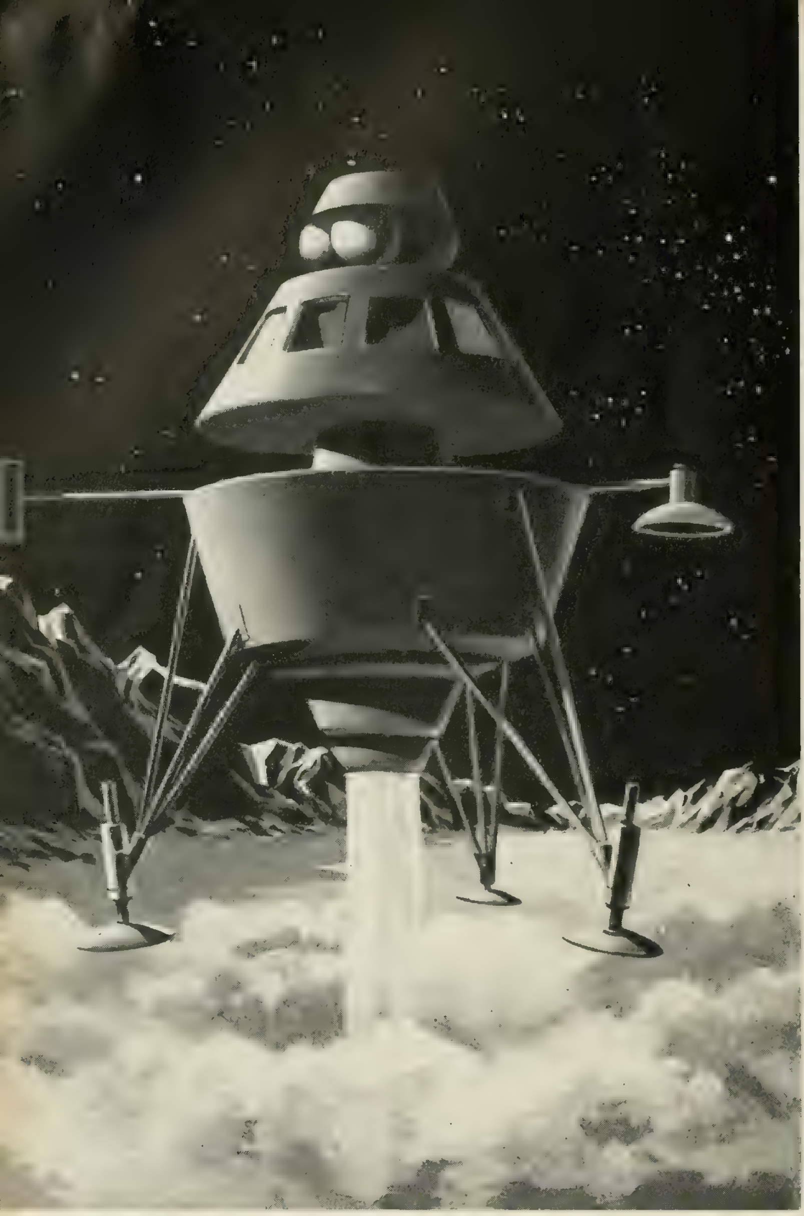
Development of stellar-inertial systems by DOD and the services is not new, nor has it been associated only with the Nortronics system for *Skybolt* or the General Precision scheme for *MMRBM*. Stellar-inertial programs have been carried on since the 1950's (the *Navaho* missile had such a system) and have also been conducted as continuing technical programs of advanced-technology R&D.

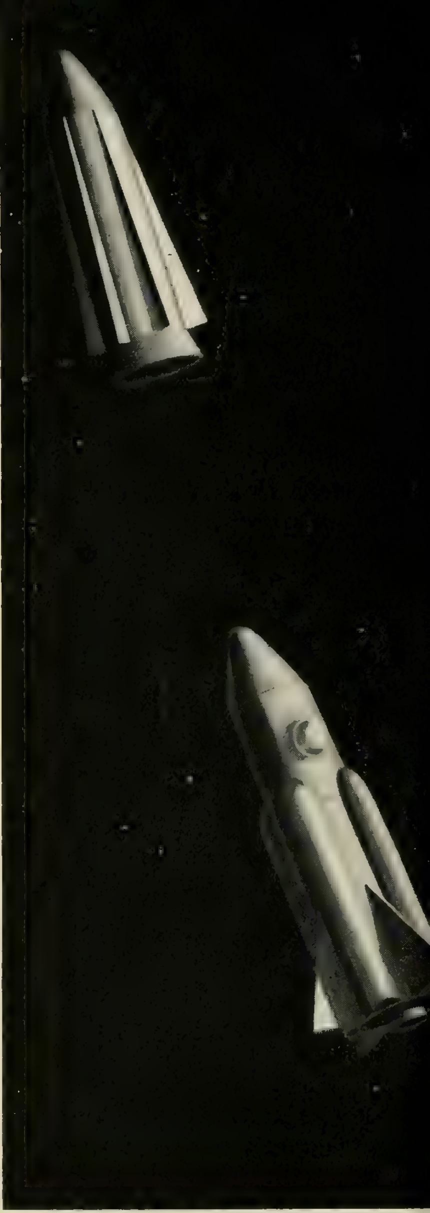
The STINGS program for *MMRBM* was actually one of feasibility. If the system could be developed and looked good, it would replace the "primary" gyro-compassing system for *MMRBM*. However, the Air Force reportedly "had no doubt that STINGS was better in the missile environment."

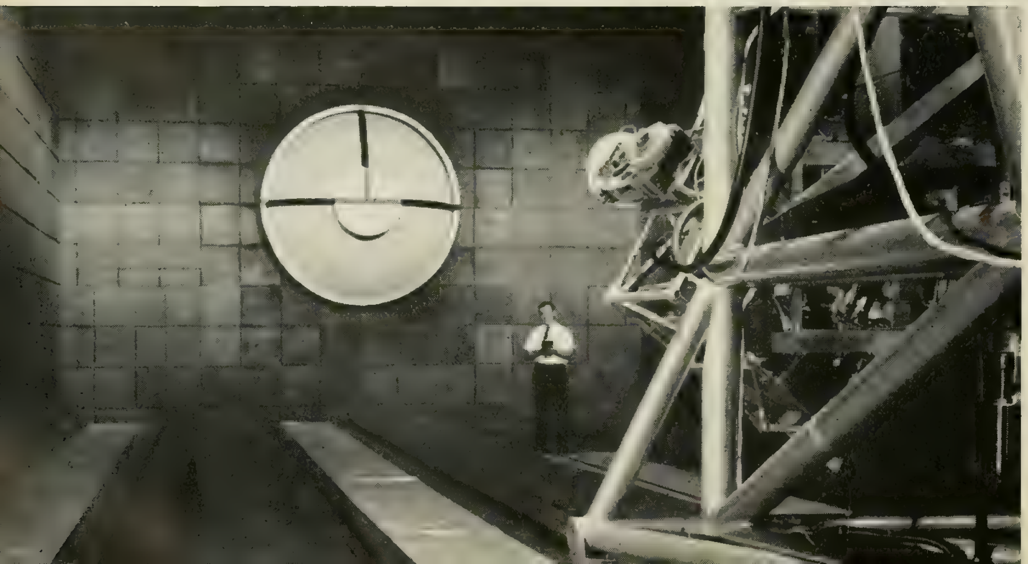
Current indecision in the *MMRBM* program will affect development of the STINGS package, but there is no question that development will continue. Decisions on the rate, source of funding, and title of the program should come this month.

DOD officials told M/R development would be continued through flight test to demonstrate the capability of the system. Though inertial systems can be tested on the ground, it is virtually impossible to test the effectiveness of stellar-inertial systems without flying them.

In the case of *MMRBM*, some STINGS hardware has been built and checked out, and GPI is still being funded monthly for the STAFF (Stellar Acquisition Flight Feasibility) portion of the STINGS program. The system is expected to be tested, probably using a *Polaris* as an interim test vehicle, "in the near term." ■







Top illustrations (le to right): Landin Rendezvous, Docking

Left: Raytheon's Pr totype Rendezvo Radar installed the Martin Mariet Company's Closu Test and Traini Facility.

RAYTHEON . . . a leader in radar for space vehicles

Raytheon — leading designer and manufacturer for ground-based, aircraft, and missile systems — has developed and is testing prototype space radars for RENDEZVOUS . . . DOCKING . . . LANDING.

Currently being explored under Raytheon's in-house space radar program are several interesting configurations. One of these, the Raytheon Rendezvous Radar, has been installed in the Martin Marietta Company's Closure Test and Training Facility at Denver, Colorado. It is applicable to such systems as Apollo, Lunar Logistics System, Mars Excursion or Command Module Satellite Inspectors, and Manned Space Stations Variations of the system are now being tested fo particular missions.

For additional information — or a discussion of how the same Raytheon integrated system capability ca be applied to your requirements — contact Neil A Montone, Director, Marketing, *Space and Informatio Systems Division, Raytheon Company, Bedford Massachusetts.*

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Skybolt

THE *SKYBOLT* astro-inertial guidance system, still being developed despite cancellation of the weapon, may prove the feasibility of slaving one or more guidance systems to a master complex and pave the way to an operational air-launching technique.

Northrop Corp.'s Nortronics Division is under contract to the Air Force Aeronautical Systems Division to prove practicality by flying two complete *Skybolt* guidance systems in one airplane—using what is known as acceleration/velocity methods.

One system will act as the master reference while the second simulates a slave system. The Northrop equipment has the instrumentation necessary to allow checking back on itself.

The current tests are being flown in a C-131B transport modified into a flying lab. Besides the two guidance systems, there is related computer and electronic equipment together with six engineers.

The two guidance systems were first operated as independent navigation systems, establishing their accuracy by comparing their star-tracked position fixes with known check points along the route.

There are two types of velocity-matching experiments—one is designed to collect analytical data to aid in evolving the most efficient methods of utilizing the technique, and the second will use these methods to demonstrate possible accuracy.

Vector matching generally involves measuring the aircraft's velocity or acceleration during some maneuver—such as a coordinated turn—using the horizontal inertial accelerometers of the slaved and master systems. A comparison of these measurements determines the relative orientation of one system to the other.

Northrop is eyeing a number of other applications for the *Skybolt* design in the general area of automatic determination of vehicle position and velocity in real time. ■

LASV Vehicles

GUIDANCE DEVELOPMENT for the Low Altitude Supersonic Vehicles, LASV-Nuclear and -Chemical, appears to be somewhat ahead of vehicle development.

Prime contractor to the Air Force for this long-term R&D program is Ling-Temco-Vought, Inc., which is pressing G&C design under two separate contracts.

One embodies the unique problems associated with the long-range, low-altitude vehicles such as extreme atmospheric buffeting, high operating temperature and the nuclear-radiation environment.

The second contract is for hardware development and flight-testing for a guidance system meeting similar requirements, but not necessarily directed toward any specific vehicle.

LTV's approach embodies a simplified inertial reference system and the use of a "fingerprint" or geographic fix-taking technique for periodically updating navigation in flight.

Details are highly classified, but it is the same system originally conceived by LTV's Chance Vought Div. over four years ago. It has been funded by the Air Force for over three years.

There reportedly have been some company-funded flight tests of the system, but the R&D status at this time has not been revealed.

The Navy has for some time shown considerable interest in an adaptation of the *SLAM* vehicle (a nuclear-powered, supersonic ram jet). It is believed that the Navy has awarded LTV a small study contract to determine feasibility for Navy use of such a vehicle. ■

Nike-X

THE ARMY'S highly-classified *Nike-X* antimissile system, actually composed of an advanced *Nike-Zeus* combined with a much smaller but very fast-reacting *Sprint* missile system, will tax the guidance state of the art more in terms of developing high acceleration, severe environment components and applied systems engineering than in totally new concepts and hardware.

Army officials say guidance and control requirements on the *Nike-X* are "pretty firm" at this point. The *Nike-X* system, like its *Zeus* predecessor, will be basically a radio-command type system with the multi-function array radar (MAR), being developed by Sylvania and termed a "significant advance" by the Army, serving as the primary sensor for the system. A MAR test facility is now being built at White Sands. The MAR radar is based upon design of the earlier ZMAR (*Zeus* multi-function array) (M/R, Jan. 22, '62, p. 29).

A new solid-state computer with increased speed and data handling capability will also be added. Sperry Rand Corp's Univac Division was recently awarded a $2.5-million contract to develop the general purpose digital computer and control switch and buffer unit for testing the MAR system.

Army officials also point out that, although *Nike-X* will have some *Zeus* components, the system will bear no resemblance to the current system being used in the Kwajalein test series.

Nike-X will be capable of improved discrimination capabilities compared to *Zeus*, will have a wider range of intercept altitudes with the addition of the *Sprint* missile to the complex, and will also be capable of being hardened to resist atomic attack.

Western Electric Co. and Bell Telephone Laboratories continue in the *Nike* system roles of prime contractor and systems designer and developer, respectively, with Douglas Aircraft Co. continuing work on the *Zeus* portions, and Martin-Orlando developing the *Sprint* missile.

Zeus Project Office at Redstone Arsenal, Ala., retains technical direction of the program. ■

Lance

GUIDANCE SYSTEM components for the Army's newest battlefield missile, the *Lance*, will be built by Systron-Donner Corp. under a $1.8-million contract.

Lance guidance—a radical simplification over conventional missile guidance techniques—was designed by the Army Missile Command, Redstone Arsenal. The automet system will contain a Donner accelerometer and velocity computer.

This contract is the first of an expected series extending over the next nine years—at an estimated total funding level between $20 and 23 million.

Very little information has been released on the Ling-Temco-Vought *Lance*, but it is known that the weapon will fly a pre-programmed ballistic path over a 3-to-30-mi. range. Accelerometers, not gyros, will sense deviations from this path and a flight control system will initiate corrective maneuvers.

Most deviations will be caused by wind velocities, and steering will be handled through thrust-vector control of the pre-packaged liquid fuel system.

The weapon contains only one gyro—for internal stabilization. This unit has an air-driven, air-floated rotor and probably functions as an open loop stabilized platform for the accelerometer. The short range involved allows this and the approach could be economical. There is reason to believe that only one accelerometer is included in each guidance system and that the gyro may be a two-degree-of-freedom type, possibly providing stabilization in pitch and yaw. The gyro is produced by Whittaker Controls and Guidance Division of Telecomputing Corp.

Automet is essentially a velocity control system that integrates the output of a modified Systron-Donner Model 4310 accelerometer to establish and maintain a pre-selected velocity for the missile.

After launch and when the preselected velocity is reached, the Automet system terminates the boost engine, maintaining velocity through a continuously variable thrust unit. This reportedly results in a ballistic path without significant deviation caused by drag or winds.

The Systron-Donner subsystem includes the accelerometer, velocity meter and velocity pre-set ground support equipment, with the single gyro providing directional control and the accelerometer handling velocity control. ■

Mauler

THE RADAR-GUIDED *Mauler* missile system will provide battlefield protection for forward Army units. It will be able to engage tactical missiles as well as high-performance aircraft.

Mauler is mounted in a pod on an amphibious carrier vehicle and possesses its own acquisition and tracking radars, computers, launcher, and communications equipment.

It was a state-of-the-art system in 1960, and the missile's outstanding feature is in the packaging of a complete system in a highly-mobile firing unit.

The solid-propellant vehicle is prepacked in lightweight cases that serve both as shipping containers and as launch tubes.

Each missile weighs about 120 lbs. and has four trapezoidal wings in cruciform arrangement at its mid-section. Behind and in line with the wings are four rectangular control surfaces that stabilize the missile in a steady roll and also maneuver the missile.

Target acquisition is achieved with a sky-sweeping antenna mounted at the back of the vehicle's rotating weapons pod. For target selection, the operator is assisted by a target-evaluation computer.

When a target has been selected, a high-definition tracking radar is locked onto it and a missile is launched. A second tracking radar then tracks the missile and feeds its trajectory data into the guidance computer in the vehicle. This evaluates the collision trajectory and issues steering commands for the missile.

An omni-directional whip antenna provides intercommunication between *Mauler* units, enabling a number of units to coordinate their activities.

Prime contractor for the *Mauler* system is General Dynamics/Pomona. The radar system is built by Raytheon Co. and the computers are produced by Burroughs Corp. ■

SSGS

THE MARCH toward a long-sought-after goal within the Air Force and Department of Defense—development of a standard space guidance system (SSGS)—took its first major out-of-house step last month with formal AF Space Systems Div. announcement of the program, dubbed A-192, and issuance of RFP's to a major portion of U.S. guidance system manufacturers.

AF-DOD intent in bringing this heretofore in-house effort to industry was first disclosed in MISSILES AND ROCKETS last month (Sept. 9, p. 16). The project, if it moves through the two-phase funded program-definition to fruition, will probably represent the largest single space guidance development project ever initiated by DOD.

SSGS essentially will be a single guidance system, though it may not be located all in one portion of the space vehicle. It will perform the total guidance function for spaceflight from launch, through injection, and throughout actual spacecraft guidance.

Such a system would be capable of military missions, including inspection and rendezvous with non-cooperative targets, but would not be limited to these missions. In so doing, it would offer tremendous economies in a wide number of program applications, spare parts, reliability development, and, primarily, in offsetting the huge development costs generally associated with developing G&C systems for individual programs.

Though SSGS is the product of a long-term separate effort within DOD, the development of the program to this stage may have played a part in the "re-orientation" of programs such as *SAINT*, which were known to have expensive G&C system development costs.

DOD has approved initiation of the first phase: to study missions, trajectories, and hardware requirements. Phase two, requiring separate approval, will investigate implementation.

About four firms will probably be chosen for Phase 1 funding.

System design is open to suggestion at this point, but there are certain requirements. Primarily, SSGS must be a self-contained system, one that can operate with ground links if desirable but "not inevitably tied to it."

The SSGS will have to be compatible with *Titan III*. It will also more than likely be designed with techniques and components of proven reliability and performance, avoiding, at least for early systems, some of the more exotic guidance methods now on the horizon. SSGS is also expected to require a modular design approach, so that sensors can be easily removed or added for particular missions.

SSGS is also being watched by NASA, at DOD's invitation, with an eye towards an even greater role for such a system. The extent of NASA participation has not yet been made clear. ■

X-20A Dyna-Soar

THE *X-20A* (*Dyna-Soar*) guidance system is now being readied for a series of high-speed sled tests at Holloman AFB, N.M., after successfully completing a seven-month flight test program down the Eglin range. (M/R Aug. 19, p. 16).

The air-drop section of the program will begin a year after the completion of the sled tests. The interim period will be used to improve and physically modify the guidance system to satisfy any *X-20A* vehicle modifications.

The Military Products Group of Minneapolis-Honeywell Regulator Co. has complete responsibility for the design, testing, operational field support and spares in the *X-20A* guidance program.

The *X-20A* primary guidance subsystem (PGS) is required to provide an accurate determination of the kinematic state of the vehicle, generation of automatic three-axis steering commands as outputs to the orbital vehicle flight control systems, and control factors that command the vehicle to follow the desired path.

The system will also provide for the generation of signals for the pilot's display, allowing manual steering and pilot decisions. A malfunction-detection ability is also required; it is handled by monitoring certain key voltages and currents within the PGS to detect a gross malfunction and initiate pilot warning devices.

The combined elements of the PGS have a total volume of 6.4 cu. ft. and a weight of about 260 lbs. About 1,000 watts of running power is needed from the ship's supply, and 5.7 lbs./min. of cooling air at a nominal inlet, temperature of 35°F is required.

The major elements and their functions include:

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The traffic center will fix the craft's position by using a satellite as a navigational reference point. Then, the fix will be transmitted to the craft via the satellite. The complete operation will take only a fraction of a second.

Continuous monitors of appropriate agencies will scan worldwide traffic patterns and, again by satellite transmission, warn any craft in danger of collision. In the event of disaster, air and sea rescues will be able to get underway without delay.

Westinghouse is evaluating the problem so that such a system can be developed at minimum cost and with maximum benefit to civilian air and sea operations.

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—*Inertial measuring unit* (IMU)—Establishes the navigational measurement reference frame, measures vehicle acceleration and provides attitude reference for steering freedback and pilot's display.

—*Digital computer*—Performs all computations for preflight calibration, alignment, in-flight navigation, guidance and display.

—*Coupler electronics unit*—Processes signals between PGS units. The CEU also processes and/or routes signals to PGS external interfaces. It transforms power from the motor-generator set into ordinary and precision voltages and frequencies, and detects catastrophic failures within the entire system.

—*Transient stabilizer*—Aids in buffering the 400 cps three-phase power to the PGS, preventing loss of data during severe outages and transients in ship's supply.

The first of two unmanned orbital flights and recovery are planned for the spring of 1966, beginning the final phase of *X-20A* systems development. Systems simulation is under way at Boeing Co., *Dyna-Soar* prime contractor, to provide the data necessary for complete equipment integration.

Present procurement plans call for delivery of 10 *X-20* vehicles—two for unmanned flights and eight to carry Air Force and NASA pilots. ■

Aerospace Plane

AEROSPACE PLANE is expected to be a two-stage vehicle capable of accelerating to orbital speeds and landing like a conventional aircraft.

When flying at suborbital speeds in the atmosphere, the vehicle will collect and liquify oxygen for use in subsequent rocket-powered flight.

Currently, *Aerospace Plane* is the subject of three $500,000 study contracts, held by General Dynamics/Astronautics, North American Aviation, and Douglas Aircraft.

These studies are funded jointly by NASA and the Air Force, but some difference of opinion on the function of the vehicle seems to exist between the two agencies.

Charles H. Zimmerman, NASA Director of Aeronautical Research, has referred to the vehicle's basic mission as "a means of transportation and logistics support for Earth-orbiting space stations." That is, *Aerospace Plane* will have no function in space other than to get there.

On the other hand, the Air Force has expressed an interest in a vehicle with more than this capability—to give them the opportunity to inspect foreign or hostile satellites.

From the guidance point of view, the Air Force approach sets a much tougher problem.

The atmospheric high-speed flight phase will mean a rapid rate of change in atmospheric parameters that will require some form of adaptive control for gain-adjustment in the autopilot control system.

Navigation requirements are mainly set by the length and variability of the flight. An advanced astro-inertial system will be required to make the vehicle independent of ground tracking stations.

Because flights will take place in both the southern and the northern hemispheres, the star tracker will need the capability of recognizing and tracking a number of different stars. This is well within the state of the art. ■

Agena-D

AGENA-D, now designated *"Standard Agena"* by the Air Force, has a guidance system that is basically similar to that of the earlier *Agenas*. Improvements in electronic packaging and sensor performance have been made.

Agena is usually launched atop an *Atlas* booster. In this configuration, guidance during the booster phase is open-loop.

During sustainer burning, closed-loop radio guidance governs the *Atlas*. On separation, the *Agena* yaw vector remains that established by the *Atlas*.

Stabilization in pitch and roll is achieved by use of a horizon sensor and a reference gyro. Attitude is stabilized to local vertical in the orbit plane of reference.

Injection of the *Agena* into the correct circular orbit is achieved by measuring the velocity increase in the line of flight, as *Agena* burning proceeds, and terminating the thrust when the desired velocity magnitude is reached.

Velocity is measured by an accelerometer aligned along the longitudinal axis of the vehicle.

Command signals for thrust termination are transmitted at UHF. In the vehicle, commands are converted to digital pulse trains that pass to a digital programmer.

The main engine of *Agena-D* is mounted in a gimbal frame that provides the capability of vertical and lateral thrusting. Engine positioning is carried out by means of an electrohydraulic system.

Vehicle attitude is sensed by three angular transducers connected to an inertial platform in the vehicle. Means for in-flight alignment of this platform have been provided by a horizon-sensing gyro-compassing technique.

The *Agena-D* to be used for *Gemini* rendezvous is equipped with a secondary propulsion system of six cold-gas jets for adjustment of vehicle attitude in orbit. These can be used to command the *Agena* in yaw, to achieve a coplanar rendezvous orbit.

A re-start capacity has also been added to the main engine.

In the rendezvous *Agena*, 96 command functions are available over the ground-to-air link. (M/R, July 22, p. 32).

Guidance contractor for the *Agena* is Lockheed Missiles and Space Company. ■

Titan III

TITAN III guidance essentially will be a modified version of that used in the *Titan II* ICBM.

Principal suppliers for the system are AC Spark Plug Div. of General Motors Corp. (inertial platform and associated electronics subsystems) and International Business Machines Corp. (computer and data processor).

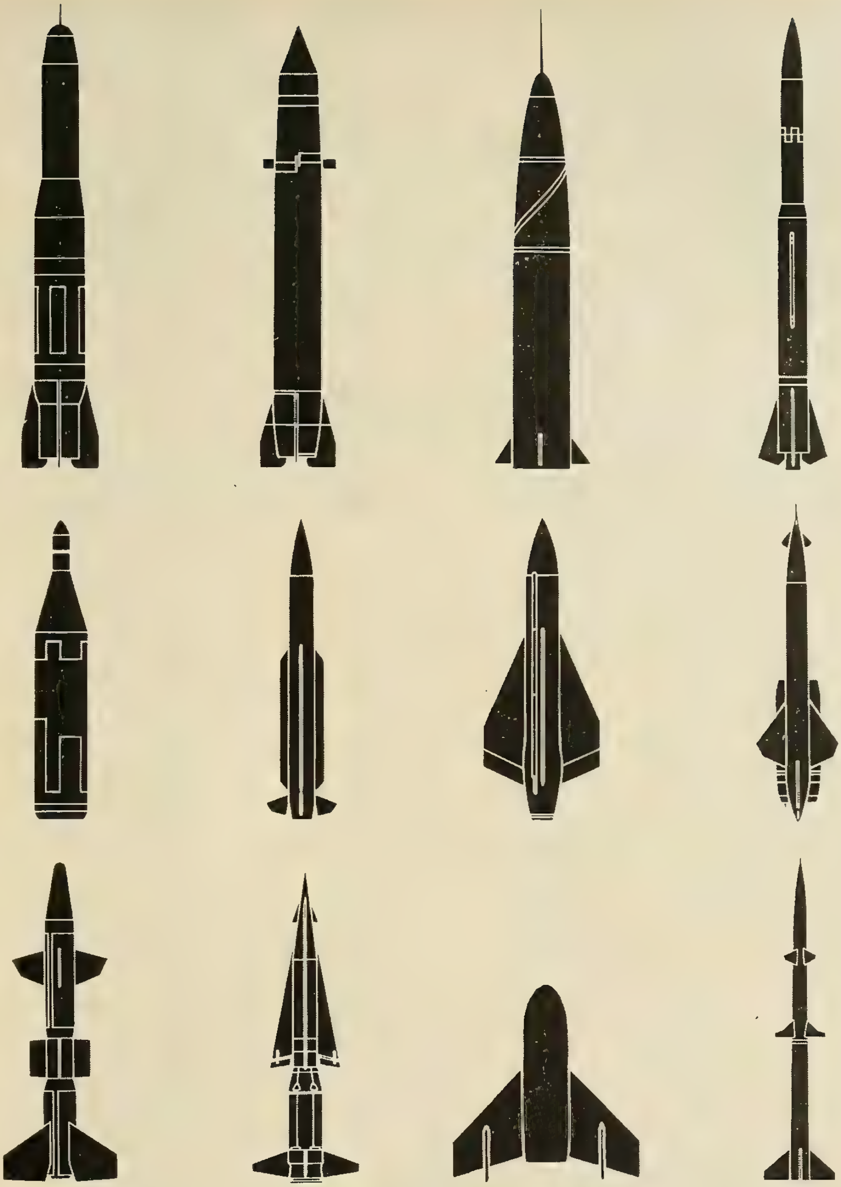
Because the large space booster is scheduled to serve as a general-purpose, high-thrust launch vehicle for a variety of space missions, principal modification to the *Titan II* guidance will be in the computer subsystem—added logic circuitry and reallocation of the memory tracks.

First scheduled test flight of the guidance system in the *Titan III-A* is May, 1964. The "C" configuration (approximating the operational booster) is to be flown in January, 1965, and it will be used to boost an *X-20* in Earth orbit late in 1965 or early in 1966.

The AC Spark Inertial Measurement Unit employs a four-gimbal, three-gyro platform with conventional integrating accelerometers and a vertical sensing element. The system employs the basic Massachusetts Institute of Technology design.

Digital velocity information is fed to the IBM computer, which is a serial binary whole-word system. The computer continually provides 3-axis steering signal to the *Titan III* control system and controls engine cutoff.

Complete system weight is well under 300 lbs. ■



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Early Programs Furnish Advanced System Fundamentals

FOLLOWING is a survey of advanced NASA systems, with emphasis on rendezvous techniques. Programs include both manned (Gemini, Apollo/LEM) and unmanned endeavors (Surveyor, Voyager). A separate article beginning on page 65 treats advanced concepts of attitude stabilization and control for observatory- and application-type satellites.

Gemini/Titan II

DEVELOPMENTS IN guidance and control systems for U.S. manned spacecraft from Project *Mercury* through *Gemini,* and into *Apollo,* in general characterize the steady growth in overall space systems design and the logical extension of techniques from one program to the next.

For example, *Gemini* will expand on the relatively simple gyro-referencing system used in *Mercury,* and will introduce the first primary inertial guidance system into U.S. manned spaceflight. Inertial guidance will form the heart of the *Apollo* program.

Gemini will also put the pilot prominently into the guidance loop, based on experience gained from *Mercury. Gemini* also will subject G&C systems for the first time to long duration flights, rendezvous and controlled reentry maneuvers.

Electronics associated with *Gemini* G&C will be solid-state, miniaturized systems, sophisticated by *Mercury* standards, but simple in comparison to microelectronics visualized for *Apollo.*

Gemini characterizes NASA efforts to utilize equipments derived from other programs. For example, both the Minneapolis-Honeywell four-gimbal inertial measurement unit (IMU) and the International Business Machines Corp. on-board digital computer to be used in *Gemini* are improved versions of equipment originally developed for the *Centaur* program.

The system, according to NASA engineers, "is a good application of what we know how to do today." It is also designed to assure that "no single failure should result in complete mission failure. If we can't complete one phase of the mission, we should be able to do something else."

The *Gemini* guidance system also reflects the growing NASA requirement that primary spacecraft guidance should be able to function as back-up for launch vehicle guidance.

For McDonnell's *Gemini* capsule, a modified Martin *Titan II* booster will be the launch vehicle. The *Titan II* will be retrofitted with the highly developed and performance-proved General Electric Mod III radio-command system that performed the launch vehicle guidance in the entire manned *Mercury-Atlas* program.

The GE system will again be used in conjunction with the Burroughs Corp. ground guidance computer at AMR. The ground computer will be used to up-date the *Gemini* on-board computer perhaps three to four times during the launch phase so that in the event of launch vehicle guidance failure during boost, the *Gemini* on-board guidance, autopilot, and hydraulics can take over (M/R, May 20, p. 43). Guidance failure correction requires extremely fast reaction time and will be automated for this reason. Manual switchover could be done experimentally.

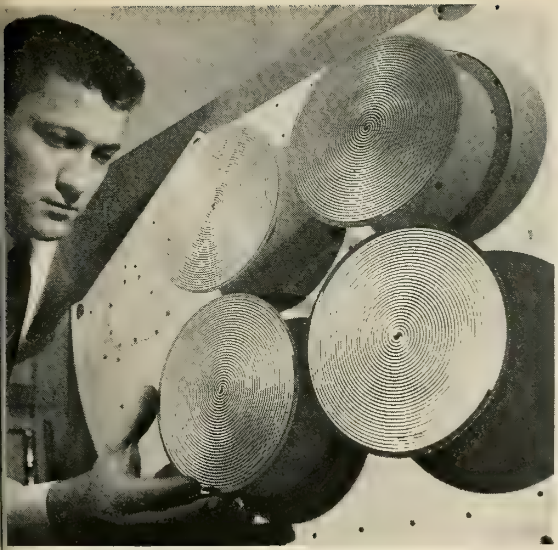
In *Apollo,* spacecraft guidance will also be capable of providing back-up launch vehicle guidance for the *Saturn.*

- **Gemini G&C**—Heart of the *Gemini* G&C is the small (30 lb.) Minneapolis-Honeywell four-gimbal inertial platform, employing three single-degree-of-freedom integrating gyros and three pendulous accelerometers. The four-gimbal system reportedly avoids gimbal-lock problems and allows complete roll freedom.

Major improvements over the *Centaur* IMU design are said to lie in improved electronic packaging and increased redundancy in amplifiers, slip-rings and control system components. Total IMU weight, including the platform, cold plate, system electronics and power supply is about 116 lb. Mean-time-between-failures figures are reportedly at 1,150 hours; however this could be increased to about 1,800 hours.

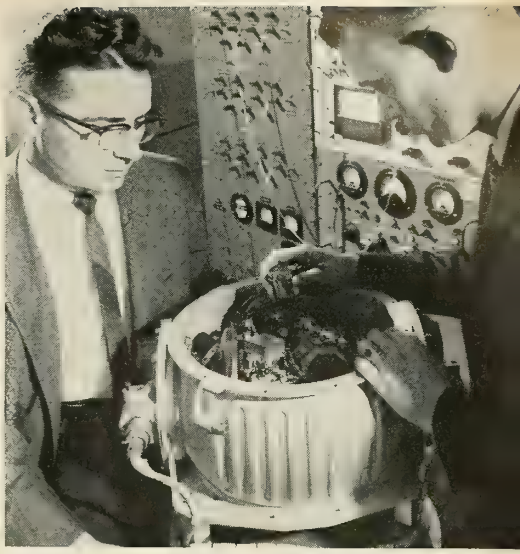
IR horizon scanners, developed by Advanced Technology Labs, Palo Alto, Calif., are used to establish local vertical in orbit. These devices are said to be a considerable improvement over the sensors used in *Mercury.* Less trouble with cloud cover and improved resolution are expected. A dither technique is used to improve averaging oscillatory motion. IMU orbital attitude level accuracy is governed primarily by horizon sensor accuracy, whereas IMU azimuth accuracy is most affected by roll gyro drift, boresight uncertainty, and azimuth angle pick-off error.

- **Rendezvous guidance**—For rendezvous maneuver with the *Agena* vehicle, the *Gemini* G&C system will rely heavily on the L-band, pulsed, cooperative radar system being developed by Westinghouse Electric (M/R, Aug. 19,



WESTINGHOUSE transmitting and receiving antennas for Gemini will be located on vehicle's front end.

ENGINEERS prepare to mount accelerometer in Apollo IMU test model.



p. 36). The system, which uses pulse round-trip-time for range measurements, and interferometer techniques for angular data, will come into play at about 250-n.-mi. vehicle separation.

Availability of an on-board computer to tie the radar to the inertial platform obviated the need for a heavy gimballed radar antenna and allowed Westinghouse to use a lightweight four-element array. The radar is designed to yield target range, range-rate and angle data to the computer and, in some degree, to the astronauts.

Radar data and IMU inputs will allow computation of velocity increments required for corrections during the maneuvers. A modified Hohmann transfer ellipse rendezvous maneuver will be carried out. Once the terminal rendezvous maneuver (from 250 n. mi.) is underway, it will take a minimum ¾-orbit to affect the join up (about 60-70 minutes). Target closure rates of about 100-150 fps will be set up after the first correction, with this maintained until about 20-n.-mi. separation exists, at which time radar inputs will be augmented with visual sightings of the flashing xenon light on the *Agena.* The radar reportedly can provide accurate digital angle and range data to the computer from 250 n. mi. to 500 ft., and accurate analog range and range-rate data for astronaut display from 300,000 ft. to 20 ft.

- **Instrument panel**—Cockpit displays for *Gemini,* being developed by Lear-Siegler, will be duplicated in some cases for both the left and right seat astronauts (left-hand will be spacecraft commander). The single attitude control stick will be in the middle. Range and range-rate will be exhibited as analog displays, and the attitude indicator is said to be much like the standard aircraft device. Details on a portion of the displays are classified.

Early *Gemini* missions will try out several rendezvous modes to check complexity and possibilities for operational use. These include: (1) full use of radar-and-computer optimum guidance (a fully-aided system, aimed at minimum fuel consumption); (2) radar and range-rate only (there is no computation or display of the spacecraft velocity increment; the astronaut follows, against a stellar background, a roughly constant true-bearing course from about 20 miles out, maintaining a constant angle between his path and the *Agena,* manually correcting any relative changes); and (3) a completely optical approach with no radar.

- **Re-entry aids**—For re-entry, the IMU and the ground tracking inputs will measure the actual spacecraft path. This will be compared with the stored programmed trajectory within the computer memory. The computer, using these inputs, will predict a new impact point. *Gemini's* landing "footprint" is roughly 100 n. mi. wide and 600-700 n. mi. long.

Ground commands to both the *Gemini* and *Agena* vehicles will move through the new digital command system being integrated into the NASA tracking network this fall (M/R, July 22, p. 32). Radiation, Inc., is building the ground portion of this system and Motorola's Military Electronics Div. is building the spaceborne equipment. The Motorola gear will be integrated within the radar and will allow a direct space-to-space means for control of *Agena* by the *Gemini* crew during rendezvous.

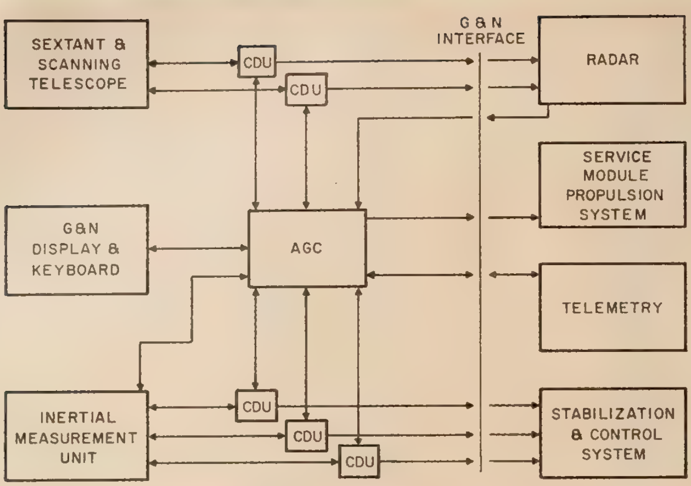
- **Space flight control**—*Gemini* flight control is accomplished via the Minneapolis-Honeywell low-power multi-mode attitude control and maneuver electronics (ACME) system operating in conjunction with the on-board propulsion network.

ACME, according to Honeywell, consists of primary and secondary three-gyro rate-gyro packages to sense pitch, roll and yaw rates; a solid-state power inverter; and two small automatic checkout equipment computers (M/R, July 2, '62, p. 18).

ACME functional design requirements, according to Honeywell, include maintaining: (1) spacecraft attitude within 1 degree of the attitude reference supplied by the IMU, radar, or computer; (2) spacecraft rates at less than 0.25 degree/sec; (3) spacecraft roll and pitch attitude within 5 degrees of the horizon sensor reference; (4) spacecraft angular rates in response to astronaut hand-controller commands in conjunction with rate gyros; and (5) spacecraft rates within 0.1 degree/sec of the commanded rate during orbit and within 2 degrees/sec during re-entry.

ACME must convert attitude hand-controller signals to continuous or discreet commands to the orbital attitude and maneuvering system (OAMS) being developed by the Rocketdyne Div. of North American Aviation. This consists of two separate systems, one for re-entry attitude control and another for orbital attitude and maneuvering control. The re-entry system is completely redundant, consisting of two sets of eight 25-lb. thrusters, using the same hypergolic fuel as the orbital control system.

The orbital control system also uses 16 thrusters, but is not redundant. Two are 100-lb. thrust devices used for acceleration; two 85-lb. units for deceleration; four, 100-lb. units for translation; and eight are 25-lb. thrusters for orbital rotation control. ■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Apollo Guidance Computer Interfaces

Apollo/LEM

THE GUIDANCE AND NAVIGATION (G&N) package that will aid U.S. astronauts on their way to and from the Moon bears the unmistakable stamp of the Massachusetts Institute of Technology Instrumentation Laboratory.

The inertial measurement unit (IMU), heart of the system, is a direct outgrowth of the highly successful *Polaris* guidance development (see p. 39). Most of the *Polaris* design and many of the components are used. The *Polaris* industrial support team is also largely intact in the *Apollo* program.

Described as a "zero-miss system" by Dr. C. Stark Draper, director of the MIT lab, in MISSILES & ROCKETS early in the *Apollo* program (M/R, May 21, 1962, p. 18), the *Apollo* G&N package includes a wide range of sensors and some very complex physical interrelationships.

The MIT role, as an associate prime contractor funded directly by NASA, extends into both the Command Module (CM) and Lunar Excursion Module (LEM) guidance. The systems differ only slightly, with both cutting development costs and yielding common instrumentation and common spares.

Apollo spacecraft guidance responsibility begins after translunar injection and continues through re-entry. The system will also monitor *Saturn* launch vehicle guidance, with take-over capability should boost guidance fail. The unit could also handle translunar injection if required.

The basic *Apollo* G&N package includes the IMU, optics (space sextant and telescope), and computer. The radar package is considered part of the LEM system.

The IMU, around which the system is designed, is being built by the AC Spark Plug Div. of General Motors. AC Spark also has responsibility for guidance system assembly and test, and will supply a major portion of the ground support equipment (GSE). Guidance contractors generally will supply GSE for their own equipment.

- **IMU details**—The IMU consists of an inner member stable platform isolated from spacecraft attitude motion through suspension within a three-degree-of-freedom spherical gimbal system with associated inter-gimbals.

Mounted to the stable inner gimbal will be three 2.5-in.-dia. inertial rate-integrating gyros. These are single-degree-of-freedom, magnetically-suspended, floated instruments. Also, three 1.6-in.-dia. pendulous integrating gyro accelerometers, supplied by the Sperry Gyroscope Co., are mounted to the same gimbal member. Two units are mounted horizontally at 90 degree angles from each other, and the third is mounted vertically. All inertial components use advanced pulsed torquing techniques, yielding digital outputs.

The IMU is spherical and about 15 in. in diameter, with end caps that extend the end-to-end measurement to 18 in. IMU will weigh about 60 lbs.

The sextant and telescope, being developed by Kollsman Instrument Corp., weigh about 35 lbs. The telescope is described as a movable (through more than 100 degrees) line-of-sight (LOS) instrument using relatively conventional techniques. The device provides two fields of view (60 and 20 degrees) and has two magnification settings (1X and 3X). Unit will be used for general recognition purposes, land sightings, and for star field acquisitions.

The sextant is described as a double LOS instrument, with one LOS movable for star acquisition and the other fixed to the spacecraft, parallel to the trunnion axis of the sextant. Magnification is 28X and field of view is 1.8 degree. Both of these units are operated manually, according to NASA. A change in the sextant field of view is accomplished by replaceable eye pieces. NASA also reports that Kollsman has developed a photometer attachment for the optics, which can be used for horizon determination based on brightness levels.

Both optical pieces are mounted in a bellows assembly within the structure aboard the CM. The optics and the IMU are also mounted on a common navigation base—a very rigid beryllium structure designed to maintain correlation and stabilities between the two units.

The rigid structure is attached to the spacecraft, aligned only to within minutes of arc, basically paralleling the slope of the spacecraft shell. Alignment between the optics and IMU on the navigation base is more critical and is held to within seconds of arc.

- **Optics strain technology**—The optical unit, according to NASA, will possess capabilities never before required of navigation instruments. In this respect the optics must be considered as the portion of *Apollo* G&N that places the greatest strain on the state-of-the-art. The unit will base navigation sextant measurements on the illuminated Earth or Moon horizon, on Earth and lunar landmarks, and the times of star occultation, or eclipsing by the Earth or Moon.

Kollsman will also supply a large map and data viewer mounted in the CM cockpit. The device is essentially a film projector, with cartridges inserted to call up displays of star fields, lunar surface, landing sights, and recommended star sighting and fix points.

Since work began on it early last year, the on-board digital computer, being built for Massachusetts Institute of Technology by the Raytheon Co., has undergone evolutionary changes that have resulted in significant memory capacity increases and weight reductions.

The computer has both a wired core-rope memory with a 25,000, 16-bit word storage capability for fixed data, and a 1,000-word, coincident-current ferrite-matrix erasable "scratch pad" memory for variables.

Associated with the computer are a 21-digit character display and a 16-button keyboard for astronaut use, and a system of built-in relays for remote source (data link) inputs. The keyboard uses a unique verb-noun type format to improve man-machine understanding. Meaningless paired verbs and nouns will activate an "illegal order" light in the cabin, similar to a "tilt" light on a pinball machine.

(Continued on page 56)

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• Computer refined—The computer, with a memory cycle time of 11.7 microseconds, single addition time of 23.4 microseconds, and double precision multiply sub-routine time of 780 microseconds, is said to be capable of up to nine simultaneous parallel computations.

It has been re-packaged into two trays—one logic and one fixed memory. Trays are mounted directly to the spacecraft cold plate, eliminating some structure, easing heat transfer problems, and improving integrity. The system also has been modularized, and has gone from sub-miniature components and techniques to microminiature techniques, using Fairchild Semiconductor Micrologic.

In its current configuration, the computer weighs about 60 lbs. (it weighed 100 lbs. earlier in program), and the wire core-rope memory capacity doubles the early capability. Efforts continue to improve on size reductions and spare-carrying capability. Essentially, two complete sets of computer modules are carried on-board for switching or repair.

Two other key subsystems servicing the G&N package are being supplied by AC Spark. These include the power and servo assembly (PSA) and the coupling data units (CDU). The PSA handles movement and regulation of spacecraft power to guidance components. It is packaged with servo amps right in the PSA so that lead lengths are significantly shortened. The five CDU's are essentially data converters, interconnecting the computer, optics and IMU.

In general, *Apollo* guidance involves steering the craft during thrusting periods and navigation involves determining position during the long periods of translunar and orbital coast. In this sense, the IMU is the guidance instrument and the optics are the navigation devices.

However, G&N are closely tied together. Navigation systems will provide data on initial conditions and instructions on desired velocity changes for guidance during thrusting phases. Conversely, guidance will measure velocity changes during thrust to update navigation data.

For example, before each use of the IMU, the *Apollo* navigator will align the instrument through optical measurement of star angles. Two star sightings will be required to yield a complete three-degree-of-freedom fine alignment.

• Star sighting data—To achieve a fix in space, data on three star points will be required, though the sightings need not be taken in rapid succession.

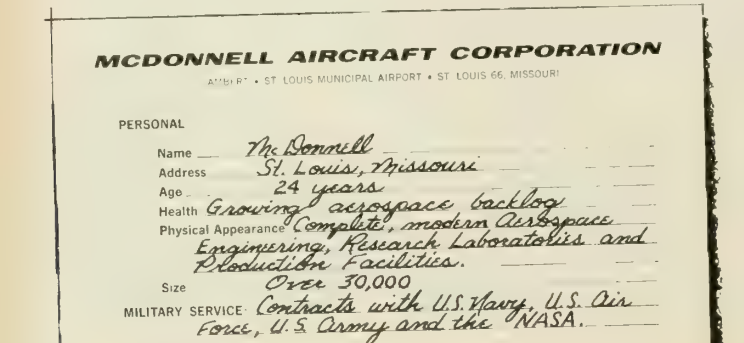
In practice, the navigator will make single-star fixes at specified time intervals throughout the flight, with the G&N system and computer keeping track of both time between sightings and spacecraft free-fall within the star-oriented IMU reference frame.

About 40 separate star sightings on each Moon-bound and Earth-bound leg are anticipated, but only three actual velocity corrections are anticipated each way. Each star sighting will be used by the computer to optimize all six components of position and velocity.

During periods of velocity correction, the IMU will measure velocity increments and spacecraft attitude and, through the computer, signal the stabilization control system for changes in thrust direction to achieve steering. Meanwhile, on the basis of these velocity increment measurements, the computer will determine and command rocket engine cut-off.

Final star and landmark sighting and platform alignment will be made just before re-entry, with the G&N system maintaining spacecraft attitude control through the command module's reaction control system. G&N will command proper angle of attack and roll rates to control re-entry within the ±8-10 mile re-entry corridor.

• Radar discussed—The radar portion of *Apollo* G&N actually falls within the LEM G&N responsibility and has been sub-contracted to RCA's Burling-



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ton, Mass., division by Grumman Aircraft Engineering Corp., LEM prime contractor. Though not considered a part of the MIT responsibility, the Instrumentation Lab did provide inputs during design consideration.

The LEM radar arrangement (M/R, July 15, p. 26) will include two basic units—a cooperative rendezvous radar, and a Doppler landing radar. Both will operate at X-band. The rendezvous radar, mounted on LEM, is expected to be conventional in design, operating with a transponder aboard the command module. It will measure range, range-rate, LOS, and LOS-rate.

RCA probably will build the rendezevous radar in-house, and will subcontract the Doppler landing radar portion. Safety considerations may call for a redundant rendezvous system, with radars and transponders on both the LEM and CM.

The landing radar will make three component velocity measurements and compute altitude. Although some design inputs are still not certain, the unit is likely to be a 2-3 beam coherent Doppler system with two directional positions. Interrupted CW, pulsed CW, and straight CW Doppler will probably be investigated. NASA says landing radar hardware, though not yet contracted, should be available in 6 months.

- **LEM CM similarities**—The remainder of the LEM G&N package is very similar to that in the CM. The IMU's are identical, as is the computer on the module level (though differently programmed). LEM contains a telescope similar in design to that in the CM, but no sextant. The system also uses a navigation base, though smaller, and the same CDU arrangement. The mary G&N system on the CM weighs 500 lbs. in comparison to about 350 lbs. for LEM.

These figures could change, depending on number of spares carried. G&N for the *Apollo* command module will occupy a space 4 ft. high, 2 ft. deep, and 3 ft. wide. Peak operating power needs will be several hundred watts. Standby will require less than 100 watts.

Further guidance insurance for *Apollo* both in CM and LEM is found in elements of the stabilization and control system. Minneapolis-Honeywell is supplying this package for the CM, with a number of sub-contractors, primarily RCA, expected to feed the Grumman S&C system for LEM.

In the event of failure of the primary guidance system, these systems could serve as a backup.

The M-H stabilization system is basically a strapped-down inertial system using three body-mounted attitude gyros, a pendulous accelerometer, and three rate gyros. As a backup system, they could supply attitude angles, rates, and acceleration data for guidance. ■

Saturn Booster

THE HUGE *SATURN V* booster that will lift the *Apollo* spacecraft from its Merritt Island launch site—first into Earth orbit and then into its translunar trajectory—embodies what must be considered as state-of-the-art advancements in its design.

NASA's Marshall Space Flight Center, which has retained in-house control, has designed a highly flexible system the space agency claims can provide G&C for a variety of vehicle configurations and engine specifications, coupled with a large assortment of mission objectives and flight paths.

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MSFC has made a major attempt to make both the *Saturn IB* and *V* vehicle G&C systems identical. Mechanization has also been directed at integrating both the guidance and the control functions through hardware sharing. For example, the guidance system's stable platform also provides the reference for the control mode.

To meet the complex launch guidance requirements for *Apollo*, and some anticipated post-*Apollo* missions, MSFC has developed a concept it calls "adaptive guidance mode." AGM, which actually relates to a mathematical structure, works by accepting the real-time vehicle flight variables and engine parameters as initial conditions that are used by an on-board digital computer to perform an in-flight solution to the guidance equation. In so doing, NASA says, it defines an optimum flight path for the vehicle that meets the particular mission requirements.

- **Perturbance correction**—Computer output dictates direction of thrust applications through generated steering commands to the gimballed *Saturn* engines, via hydraulic actuators. The computer also provides engine cut-off commands.

With trajectory selection based on on-board measurements made continuously during the flight, the vehicle is oriented and stabilized along an optimum path even under perturbing conditions.

NASA also points out that the powered flight time of the *Saturn* is quite long by ballistic missile standards, ranging from approximately 600 seconds for Earth orbits to 1,000 seconds for lunar probes. With a multi-engine, multi-stage booster such as *Saturn*, mission completion is possible even if there is some engine failure. With a failure, NASA says, high injection accuracy would be difficult to obtain with guidance schemes using conventional time programs, or other programs predicated upon a single reference trajectory.

Saturn guidance is still classed as an all-inertial system, but there are several non-inertial type sensors under development for possible use aboard the vehicle for certain mission requirements. There are probably several missions that could be handled by the inertial system alone.

- **Three Subsystems**—The G&C consists principally of three major subsystems—the inertial platform and associated components, a general-purpose digital guidance computer, and an analog control computer with sensors and actuators. Interface requirements between these subsystems is provided by the on-board data adapter.

Though there is telemetry and some sensor equipment scattered throughout the vehicle, the great bulk of the guidance equipment for all stages and the entire vehicle is contained in the *Saturn* instrument unit, mounted atop the third stage and beneath the payload.

The inertial platform under development for *Saturn* can be either a three- or four-gimbal system, according to NASA, depending on the anticipated trajectories and the degree of maneuvering required. Use of a four-gimbal system (with pitch axis redundancy) would give unlimited freedom about all axes. It would also prevent gimbal lock problems. Bendix Corp.'s Eclipse Pioneer Div., Teterboro, N.J., is building the platform for MSFC.

The stable inner element carries three single-degree-of-freedom gyros for stabilization, three orthogonally-mounted pendulous integrating gyro accelerometers, three pendulums for in-flight leveling, and a prism and digital encoder for azimuth alignment. Gyros, accelerometers, and pendulums are gas-bearing devices. Additionally, pancake resolvers are mounted on each gimbal for guidance and stabilization.

The digital guidance computer being developed for MSFC by IBM in Owego, N.Y., will employ advanced packaging techniques including deposited circuitry and solid-state non-destructive memory with random access. The device is also expected to have a low-power requirement and an expandable memory.

IBM is also making the data adapter package, which will have matching computer circuitry. This unit is expected to have a variety of computer-related functions, but which are not made part of the computer since these functions are likely to change with mission or vehicle changes, or with evolutionary design alterations. As an example of its role, major modules will probably include: the attitude command system, telemetry shift register and counter, accelerometer signal shaper, computer turn-on sequencer, radio-command system switching and other telemetry shapers.

- **Steering the Saturn**—The *Saturn* control system computer being built by Electronic Communications, Inc., St. Petersburg, Fla., will be an analog device that accepts attitude-error information from the inertial platform, control system accelerometers, and rate gyros, and computes proper steering signals for the gimballed *Saturn* engines.

Control rate-gyros will be single-degree-of-freedom devices, using fluid damping, each having an angular variable differential transformer pick-off. Full scale range is ±10 deg/sec. The Minneapolis-Honeywell gyros also have self-checking features to allow remote testing. Three rate gyros will be used in the system.

Two control-system accelerometers made by Statham Instruments, Los Angeles, will measure lateral acceleration perpendicular to the longtitudinal axis in the pitch and yaw directions. Outputs are used in the control system to reduce lateral structural loading.

The accelerometers are linear, spring-mass, fluid-damped instruments, using an inductive type pick-off. Range is reportedly ±10 meters/sec^2. AC signal output is amplified and demodulated within the accelerometer package. This unit also contains remote checkout features.

In addition to the inertial system, *Saturn* will have a digital command receiver that will tie in with ground tracking stations soon to be equipped with the new digital command system (M/R, July 22, p. 32). The receiver will give the flight system the capability of being up-dated if needed by ground tracking data. No contractor has yet been selected for the receiver.

- **IR horizon sensors**—*Saturn* will also have four infrared horizon sensors being developed by the Martin Co. Accuracy of these devices is expected to be within about 0.1 degree from altitudes of 400 kilometers or more.

These sensors primarily will provide attitude information during orbital coast periods. They will also serve in a backup role as an attitude reference for an on-board high-altitude pulsed-radar altimeter system. This system is being developed by Ryan Electronics for possible use aboard *Saturn*.

NASA scientists point out that while many new sensors are being developed for the booster, their use will depend first upon their performance, and secondly upon the complexity of the expected trajectories for some missions.

Perhaps the most complex new sensor being developed is a star-Sun tracker now under study by the Nortronics Div. of Northrop Corp. This unit, which uses a quadrant photomultiplier tube as the single sensing element, is being investigated as a possible route to up-date the *Saturn* inertial platform as necessary on certain missions.

The all solid-state unit will reportedly weigh about 10 lbs., and will have no moving parts. Separate Sun and star optical systems will direct the radiated energy onto the single photomultiplier element. Field-of-view of the Sun tracker is said to be one degree with an accuracy at null of 10 arc seconds. Star tracker field-of-view is one-half degree with similar accuracy.

Development effort is expected to be completed in March '64, with the unit possibly riding aboard an early *Saturn* orbital test flight to check performance. ■

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Manned Orbital Lab

U.S. DEVELOPMENT of manned orbital laboratories (MOL), or space stations, will offer considerable challenge to the G&C industry, both in development of certain new techniques and major improvements in reliability and long-life performance of existing methods.

Because the first MOL launch attempts are expected in 1965-67, the basic state of the art being developed for Project *Apollo* will probably be applied.

Top NASA planners in this area feel strongly that early space station attempts will indeed be based on an extended-*Apollo* design, perhaps allowing two to three men to embark on a 100-day mission. The next step may take the form of a four to six-man craft, perhaps based on concepts being pursued by NASA's Langley Research Center. A 1-year mission is envisioned with additional launchings for logistics purposes. "Rendezvous must be made a routine practice for this," says NASA.

Beyond this, considered by NASA as second-generation, are the large 12 to 24-man laboratories, such as are being conceived in studies at Douglas Aircraft Co. and North American Aviation, Inc., capable of 3 to 5 year missions.

Choice of some configurations in the space station program is expected from NASA next Spring.

• **Two types G&C needed**—Two basic classes of G&C equipment will be needed—one for station-keeping and another for experimental payload (many of which could easily be guidance-type experiments). These new and improved guidance experiments tried out aboard an MOL could include, according to NASA, laser ranging systems, new horizon scanners and celestial navigation devices, and very long-life inertial platforms. "Do you push the state of the art to develop inertial systems that will last for a year, or do you just replace a system with a logistics capability?" NASA asks.

For the small MOL, planners feel booster guidance will probably fulfill the orbital injection requirements. Station-keeping and attitude control for stations in fairly low orbits will probably be complicated by the need for periodic re-boosting of the station to compensate for orbital degeneration. Several firms are now studying this attitude requirement.

Whereas a great number of experiments expected to be carried aboard MOL's will not require stabilization accuracies any greater than ±10 degrees, guidance and scientific experiments needing precise pointing may demand arc accuracies up to 0.1 second. This could require either "hanging it out the window with its own stabilization system, or providing an independent suspension system within the station."

• **Crew presents balance problems**—"Having man aboard is certain to foul up the stabilization problem," according to NASA. For example, "if initial flights show that man cannot operate efficiently under zero-g for long periods, the space station will have to be rotated to induce artificial gravity that will complicate both solar cell pointing and dynamic stablization problems. As mass shifts within the station, the station will begin to wobble, requiring some sort of damping system. This is a new requirement and a very fertile one for industry."

Other questions arise, according to NASA, out of the biomedical experiments that are certain to make up much of the payload. "Certain re-entry conditions can be simulated by a small, high-speed centrifuge aboard the MOL. Do you counter this motion or use it as a stabilization device itself?"

General criteria to be followed by NASA in defining what experiments should go aboard an MOL include cost and testing requirements. "Cost will be a primary consideration. Can it be tested on the ground? Is a final proof-test in space necessary?" ■

Ranger Lunar Hard Lander

THE FIRST of the Block III *Ranger* lunar-probe series, *Ranger IV*, expected to be launched late this year, will contain guidance and control design changes aimed at improving the unenviable launch record which has so far plagued this program.

Ranger, developed by Jet Propulsion Laboratory, will be placed first into a parking orbit and then injected onto its lunar trajectory using the *Atlas-Agena* guidance system. The spacecraft guidance system, NASA engineers report, will be able to correct to some extent for injection outside the specified corridor.

The guidance system is basically radio-command, with some on-board inertial elements for reference during mid-course maneuvers. NASA engineers told M/R that there will be a major attempt to shape *Ranger* trajectories so that with good injection there may be no need for mid-course or terminal corrections.

After injection, the spacecraft goes into a slow roll, using conventional photomultiplier devices as solar sensors for initial yaw and pitch orientation and an Earth sensor, composed of three IR elements, for roll. Sun lock-on is expected to occur 80 minutes after launching. The IR sensors will also aid in pointing the high gain (18 db) directional parabolic antenna toward the Earth. This will take place about 10-12 hours after launching. The antenna, on an arm of the spacecraft, will actually be pre-set prior to launch so that it will serve as an Earth acquisition aid. Readout of its angular position will also help to verify spacecraft attitude.

NASA reports that the look-angle of the *Ranger* Earth-sensor has been narrowed via a redesign which, in effect, cuts down the angle at which sun light can get at the sensor to complicate its Earth-sensing performance. This also aids launch problems, "increasing the number of days in the month we can fly from 4 to about 7-8."

Trajectory measurements and mid-course correction computations are made by the DSIF and transmitted to the spacecraft for computer storage and eventual execution upon command via the radio command link. About 16 hours after launching, an execute command is sent which begins spacecraft reorientation.

Ranger attitude control has been enhanced by making the cold nitrogen gas system completely redundant.

The on-board central computer and sequencer (CC&S), which failed on *Ranger IV,* has also been redesigned as a completely solid-state unit using screened, high-reliability components. In addition, its general purpose role has been altered somewhat by removal of circuitry which is no longer judged necessary for certain mission plans.

Nortronics Div. of Northrop Corp. is building the attitude control system and the CC&S. Texas Instruments is supplying the radio-command system.

Engineers also point out that a computer back-up exists for certain functions in the form of timer devices and back-up commands so that there are failure modes which still allow mission completion.

If a mid-course correction is required, the spacecraft must be reoriented to place the mid-course motor thrust vector in the proper direction. The on-board inertial reference system, three Minneapolis-Honeywell inertial gyros, is activated prior to reorientation and used during the mid-course phase. A low-gain, omni-directional antenna used for telemetry and communications early in the flight prior to orientation of the high-gain device, is also used during the mid-course correction.

Another important guidance change involves the use of a timer rather than an accelerometer to control the burning time of the mid-course motor.

After correction, the gyros are shut down by the computer-sequencer unit and the Earth-Sun sensor alignment

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process is begun again.

The terminal guidance maneuver is a radio-command operation which basically aligns the on-board TV camera axis with the velocity vector to prevent "swearing" of the TV pictures taken prior to lunar impact. *Ranger* will carry six RCA TV-cameras. The RCA contract is the largest single system award in the program.

As a result of inputs from the successful *Mariner II* probe, it was also determined that *Ranger* could handle larger solar panels, rectangular in shape rather than tapered. ■

Surveyor

THE *SURVEYOR* spacecraft's guidance and control system will be the first to soft-land a U.S. capsule on a lunar or planetary surface.

The inertial-reference radio command system accounts for some 86 lbs. of the spacecraft's 2,100-lb. weight.

In the transit phase of the flight to the lunar surface, *Surveyor* will be three-axis space stabilized. It will be Sun- and Canopus-referenced, using rate gyros.

The inertial reference system will be employed during the mid-course maneuver some 20 hours after launch. It features strapped-down gyros in the autopilot with an integrating accelerometer.

The most critical phase of the flight, however, will be the terminal descent to the lunar surface. Here, the system will use altitude marking radars, radar altimeter, Doppler velocity sensor, autopilot and analog computer. Velocity during the early descent will be controlled by the 1,200-lb. solid retro rocket motor. Nitrogen gas vernier engines—also used in attitude corrections—will be employed for the final descent.

As the spacecraft approaches the Moon, the letdown maneuvers are initiated. DSIF radio command aligns the thrust axis of the spacecraft with the perpendicular line of the landing surface.

RC also provides the angle to align the directional antenna for sending TV pictures back to Earth. It also supplies power to the radar equipment for two minutes prior to the main retro ignition.

It then switches on the altitude marking radars, which fire the retro and vernier motors some 56 miles above the surface at a velocity of 8,600 ft./sec.

The retro will fire ½ second before the three verniers. At this point, the integrating gyros of the inertial reference system tell the verniers what thrust level is needed to maintain proper attitude.

At 28,000 ft., the main retro will burn out and be jettisoned. The radar altimeter then takes over control of the vernier jets. When the spacecraft reaches a velocity of 10 ft./sec., the radar altimeter control is removed and a signal automatically will slow the spacecraft to a velocity of 5 ft./sec. The vernier engines will be shut down at an altitude of 13 ft. above the surface.

Surveyor's guidance and control system may eventually have another critical job. NASA still has not decided how it will control the *Surveyor* roving capsule which will roam over the lunar surface transmitting data back to Earth.

One concept calls for the use of the spacecraft's guidance and control system to transmit signals to the rover. ■

Mariner

The JPL-designed *Mariner* spacecraft slated to fly-by Mars late next year will build heavily upon the design of the successful *Mariner II* fly-by of late last year, but there will be some important engineering changes required.

Primary change is the shift from 3-axis stabilization via Earth-Sun sensors to a Sun-Star system, using the star Canopus, a very bright star in the southern celestial hemisphere.

Mariner will also build upon the JPL design laid down in *Ranger* (see page 60) in that it will include both radio-command guidance and an inertial guidance mode used during the mid-course correction phase. Due to the length of a Mars mission, more than one mid-course correction may be required. This may require some modification in the basic *Mariner II* mid-course motor to be used which may now have to burn longer and have a restart capability.

DSIF tracking inputs concerning angular positions, radial velocity, range, and range-rates, and trajectory computations, are sent via the radio command system, stored within the solid-state digital computer and executed by real-time ground command. Motorola is supplying the command in-flight sub-system. The central computer and sequencer hardware, supplied by Nortonics Div., is different from *Ranger*, but the unit performs essentially the same functions.

The Sun sensors, about 10 sensitive elements, provide pitch and yaw inputs with essentially an unobstructed field of view. There are both primary and secondary sensors for fine pointing.

The Canopus sensor, being developed by Barnes Engineering Co., will be a pre-programmed, single-star device designed around an image dissector tube. Accuracy is expected to be ±0.5 deg. Canopus is said to be the second brightest star in the sky. Ground inputs are expected to be used in conjunction with the tracker to insure proper acquisition. The unit will also perform a secondary role as an Earth sensor for early portions of the flight.

The mid-course inertial sub-system, a key to mission guidance accuracy, is essentially a strapped-down system with no stable platform. Initial gyro reference is provided by the solar and stellar sensors which are then shut down during the mid-course correction.

Three single-degree-of-freedom gyros are body-mounted along three mutually perpendicular axes. The gyros are capable of independent operation as rate or position sensing devices. During cruise, after mid-course correction, the gyros are shut down with damping provided by feedback compensation of the switching amplifier. Texas Instruments is supplying the inertial elements and associated electronics. TI is also supplying data encoders.

Mariner's mid-course motor, according to NASA, can burn for as little as 0.2 sec and increase the velocity of the spacecraft as little as 0.7 fps or as much as 200 fps. To accomplish this delicate control, NASA reports use of a timer in lieu of an accelerometer is being considered, as is the case with Block III *Ranger*.

Mariner attitude control will also be by cold nitrogen gas and will be partially redundant. The system will be activated when sun sensors indicate more than ½-degree deviation. ■

Voyager

IF CURRENT NASA in-house and industry studies lead to a decision to approve the space agency's *Voyager* program, aimed at ejecting one or a series of 1,000-2,000-lb. capsules onto the surface of Mars and Venus, guidance and control approaches are not expected to differ greatly from those developed throughout the basic JPL lunar and interplanetary program.

Though JPL is studying *Voyager*, the awarding of parallel study contracts to General Electric and Avco is also aimed at bringing in more than one approach to accomplishing the job. In addition to the two funded firms, NASA reports that other firms—Lockheed, Martin, and Boeing, on company

(*continued on p. 65*)

Giant RIFT: it will pioneer nuclear propulsion in Space

A new kind of power will be needed to propel America's manned spacecraft to the planets. Nuclear propulsion may be the answer. A nuclear rocket might be the ideal upper stage on the huge multistage boosters. It would carry up to ten times the payload of the chemical stage it would replace. The National Aeronautics and Space Administration and the Atomic Energy Commission are cooperating in the Rover nuclear rocket program to demonstrate the feasibility of nuclear propulsion. NASA has chosen Lockheed to design and build the enormous nuclear-powered RIFT (Reactor-In-Flight-Test) test vehicle, 33 feet in diameter and 124 feet tall.

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money, have "also been doing their homework in this program and are making inputs." Results of the GE and Avco studies are expected to be presented to NASA later this month, and a program decision is expected later this Fall.

Though the studies are not yet completed, NASA anticipates that *Voyager* G&C would again follow closely the pattern of *Ranger-Mariner* development, using DSIF radio command with solar and stellar (Canopus) sensors and an inertial mid-course capability.

Voyager will be programmed so that the bus, or main portion of the spacecraft, goes into orbit around the planet. However, current plans call for the bus to first eject one or two capsules "quite a way out, hours before encounter, so that the capsule will land before the bus is put into orbit."

The capsules will probably be sterilized, but not the bus. The capsules will be spin-stabilized with the separation impulse imparting the required impact trajectory. Landing accuracy is important, and NASA hopes to be able to land these capsules within ±3-5 degrees of the desired latitude and longitude on the surface.

Voyager will be greatly dependent upon the *Mariner B* series of spacecraft which will first attempt spinning, separating, and landing of capsules onto the Martian surface. The *Voyager*, since it will be larger, should be more accurate.

A cold gas nitrogen attitude control system will also probably be used.

Current industry studies are focusing on a 6000 to 7000-lb. injected payload, including capsule weight. This is the weight currently conceived as being necessary to do the job.

Saturn 1B with a hydrogen-oxygen or hydrogen-fluorine (M/R, Sept. 2, p. 14) third stage could probably fill the bill, according to NASA, though booster choice is not at all firm.

G&C nasa systems

New Satellite Systems Demand Accurate Attitude Controls

OBSERVATORY and application-type satellites, because they can yield no better data than their attitude-control systems will permit, are calling for corrections of effects that earlier were considered minor. This includes, for instance, for *Syncom*, the triaxiality effect of the Earth, not even known to exist when the first *Vanguard* went aloft.

These control requirements mark the high accuracy needed to assure correct positioning of spacecraft antennas and sensors so that signals can be efficiently received and transmitted.

New techniques are being introduced for this work, such as bi-propellant attitude-control systems, active magnetic dumping of momentum, and star and Sun trackers yielding accuracies within arc seconds.

Advanced Application Systems

Syncom satellites call for the most precise attitude and orbital control of any satellites yet fired in the U.S. space program.

Designed to hang suspended in as near a fixed position over Earth as possible, they must also have their antennas properly oriented so Earth signals can be received and transmitted. The spacecraft, as a consequence, have to be placed in near circular orbits in a 22,300-mi.-high band over the Earth's equator. At the same time, they have to be rotated 90° with respect to their orbital plane in order for the communications system to function properly.

Two *Syncoms*—*Syncom I* and *II*—have already been fired and an *Advanced Syncom* is under NASA study, but not yet an approved project. Chances are it soon will be placed under development as a follow-on to the highly successful *Syncom II*.

Syncom I, the world's first satellite known to have been shot into a synchronous orbit, launched last February, lost radio contact with Earth when its apogee motor was fired. This motor is used to insert the spacecraft into circular orbit at synchronous altitude. Visual observation, however, confirmed the fact that the satellite did achieve a near-synchronous orbit.

Syncom II, thrust into synchronous orbit July 26, has been in operation since that date, handling voice, teletype, facsimile and data transmissions between surface stations at Lagos, Nigeria, and Lakehurst, N.J.

● **System similarities**—The attitude stabilization and control systems of *Syncom* and *Advanced Syncom* "will be virtually identical in principle, but not necessarily in detail," Joseph R. Burke, Chief, NASA's Communication Satellites Projects, told MISSILES AND ROCKETS. He added that they are unique systems, conceived by Hughes Aircraft Co., although NASA's Langley Field facility was working on a parallel development.

Syncom launchings, typically demonstrated by *Syncom II*, are by *Delta* launch vehicles. The *Syncom II* was launched from Cape Canaveral in an azimuth direction of about 108 degrees. At about 140 miles' altitude, the satellite was injected into a highly eccentric elliptical orbit. Object was to reach synchronous altitude so that an impulse at this point would put *Syncom II* into the desired 24-hr. orbit.

Earlier, just before the third stage of the *Delta* put the satellite into orbit, *Syncom II* was given a spin rate of approximately 150 rpm so that its attitude and that of its apogee motor would be correctly maintained during the coast period toward apogee.

The satellite was given its well-known "kick in the apogee" when the apogee motor was ignited by means of a timer aboard the spacecraft. At this point, *Syncom* had coasted for 5¼ hours up to 22,600 miles altitude.

● **Two gases**—*Syncom's* control in orbit is achieved through a nitrogen-gas system and a hydrogen-peroxide system. Two pressurized spherical tanks mounted opposite each other and connected by a manifold contain the gases for each system.

Each control system has two jets, one firing parallel to the spin axis and the other perpendicular to it. The nitrogen system contains about 1.7 pounds of nitrogen at 2,500 psi and the other system contains five pounds of 90% hydrogen peroxide pressurized to 200 psi by nitrogen. The nitrogen system has a total correction capability of about 47 fps and the hydrogen peroxide system, about 300 fps.

The original thought behind having the two systems was to use the hydrogen peroxide system for gross corrections in orbit and attitude, and the nitrogen system for finer ones, according to Burke. As it worked out, though, both systems are equally good for fine corrections. As a result of this experience, Burke is looking forward to an improved system incorporating only a bi-propellant, which would have the advantage of relatively high specific impulse without sacrificing any control capability.

After the apogee kick motor was fired, *Syncom II* was in a circular orbit at a synchronous altitude. It was found, though, that the satellite was drifting east from its intended final "on-station" position. To reverse this drift, the hydrogen-peroxide control jets were fired parallel to the spin axis in a continuous rather than a pulsed mode. The drift was slackened in this way and the period lengthened from 23 hours, 46 minutes, to 24 hours, 23 minutes.

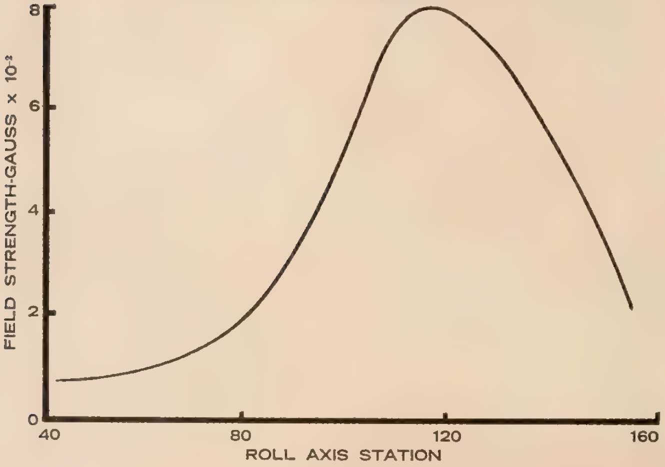
This drift-correction maneuver occurred a day after the satellite was injected into circular orbit. The spacecraft attained a higher altitude, 22,823 miles, and moved at a slower speed in relation to the Earth's rotation; thus *Syncom II* fell behind the Earth, rotating beneath it, at the rate of 4½ degrees a day. About a month later, finer corrections were made.

The attitude of the satellite had to be changed by 90 degrees so that the beamed antenna pattern intercepted Earth at all times instead of just twice a day. This meant the spin axis had to be turned normal to the orbital plane.

- **Sun sensors used**—The maneuver was accomplished on July 31, on command by the control center at Goddard Space Flight Center. Hydrogen peroxide jets were cyclically pulsed, exhaust occurring in the direction of the spin axis, which slowly precessed the satellite into the proper attitude. About 286 pulses taking place over 286 satellite revolutions succeeded in properly orienting *Syncom II.* Four sun sensors on the satellite were used to orient and time the pulses.

Two modes of operation are used in erecting *Syncom:* a synchronous controller in which the logic circuitry is on the ground and command signals are sent to the satellite for the pulsing sequence; and the quadrant mode, in which simplified logic circuitry for the pulsing is in the spacecraft. Although the latter mode is not as accurate as the former, Burke claims that both have been used and operated satisfactorily.

Total magnetic field of OAO torquer bars along spacecraft roll control axis. Each core strength is assumed equal at 15,000 CGS units.



Even after *Syncom* is on station, certain adjustments have to be made to keep it there. Reason is that Earth is not perfectly spherical, but has three axes: the pole and the major and minor equatorial axes.

These "bulges" tend to cause a synchronous satellite to drift from its station to one of two stable points along the equator. These stable points are located along the extensions of the minor axis of the Earth's equatorial cross section. They are at approximately 57° east and 123° west longitude.

At points other than these stable points, adjustments by the satellite's on-board propulsion system are required for station keeping.

- **Two-year supply**—NASA scientists point out that the propulsion necessary for *Syncom II* to remain on station is "very small." The satellite contains enough propellant, if all goes as well as expected, to last more than two years.

In addition to these effects, a satellite also is affected by the gravitational attraction of the Sun and the Moon. The correction of these luni-solar effects also requires operation of the propulsion system.

Burke pointed out that the figure-eight antenna pattern of *Syncom II* throws a lot of energy into space, energy that could better be used to increase channel capability. He said work is being done to de-spin the beam electronically, thereby increasing by 20 times the available channels.

A phased array would be used, the phased relationship of all elements changing cyclically with the spin of the satellite. This could be done by a ferrite phase shifter. The beam rotation would be opposite that of the satellite's spin, thereby generating a stationary beam with an Earth terminus and no projection into space. Hughes is working on the problem, and the solution, if practicable, would probably go into the *Advanced Syncom* when it is approved.

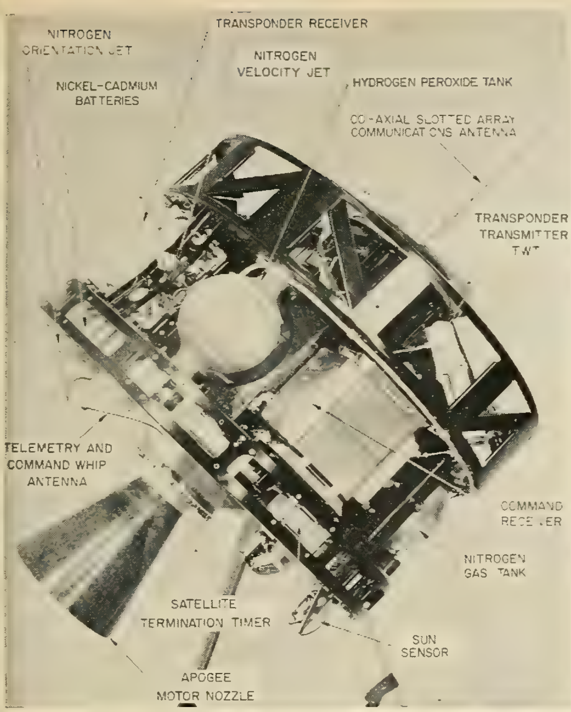
Observatory Systems

All three observatory satellites—*Orbiting Geophysical Observatory (OGO), Orbiting Astronomical Observatory (OAO)* and *Advanced Orbiting Solar Observatory (AOSO)*—have inertia wheels and gas jets for momentum dumping. *OAO,* and most likely *AOSO,* will also have a backup of magnetic momentum dumping, Jesse Mitchell, NASA's Assistant Director of Geophysics and Astronomy Programs, told M/R.

- **Magnetic dumping**—The *OAO* magnetic equipment will provide continuous unloading of accumulated angular momentum caused by steady-state disturbance torques. By preventing repeated saturation of the spacecraft's fine inertia wheels, and thus requiring gas-jet unloading, more momentum control capability is available.

Equipment operation is as follows: the signal processor accepts dc analog signals of Earth's field from the magnetometer, and wheel speed and displacement from the fine wheel and jet controllers. The signals are used to determine the magnitude and direction of the required corrective electromagnetic torque.

This information, in the form of a phase sensitive ac signal, is fed to the torquer. The torquer electronics drive three orthogonally mounted soft-iron electromagnets, developing a magnetic moment and interacting with the am-



DETAILS OF Syncom II guidance and control package, showing one of several Sun Sensors used to determine spacecraft attitude, and to generate signals for pulsing jets that control and stabilize the satellite.

bient Earth's field to produce torque.

The total magnetic field caused by the electromagnetic torquer bars along the roll-control axis is shown in the accompanying figure. The magnetic length of the torquer bars is 40 cm, and the dipole strength of each bar is assumed to be 15,000 cgs units (50% above nominal maximum).

This level of intensity is the theoretical maximum which can be generated by any one torquer bar. In practice, a simultaneous maximum field generation of all bars will not occur. From the figure, the field intensity can never exceed 0.08 gauss (8,000 gamma). In normal operation, the maximum field will be between 0.02 and 0.03 gauss.

- **Passive magnetic dumping**—The *Injun Explorer,* under development by the State University of Iowa, will be magnetically space stabilized. Although the de-spin and stabilization system has not been completely determined, it will be similar to magnetic de-spin systems used in earlier satellites.

The *Injun* will be spinning at approximately 50 rpm at the time it is injected into orbit. Calculations are being made as to what is required to de-spin. It is planned to use six permanent magnetic bars approximately 20 in. long and ⅛ in. in diameter, orthogonally mounted with possibly a polarized shorted coil.

Power to the coil will be provided through the circuitry of the magnetometers aboard the spacecraft. This system will de-spin and magnetically stabilize the spacecraft in less than two weeks, according to Mitchell.

- **OAO star tracker**—"The *OAO* is undoubtedly generating the most complicated and stringent requirements of all the observatories," said Mitchell. "We are asking *OAO,* effectively, to look at any point in the universe and do it precisely for long periods of time."

One of the key elements in *OAO* is the star tracker. "This brought up one of the thorniest problems," said Mitchell, "which has been solved in pieces, but we will not know for sure if the system will work in its integrated form until test time."

The star tracker consists of a small 3.5-in.-dia. reflecting telescope mounted in two-degree-of-freedom mechanical gimbals, according to Walter H. Scott, Jr., *OAO* Project Manager at Grumman Aircraft Engineering Corp. He describes the incoming star image as subsequently split into two light beams to provide error signals about the two gimbal axes.

The errors are determined by a novel system of vibrating reeds, which modulate the light received by a photomultiplier. The resulting error signals are used to drive the dc torquer motors on the gimbal axes. Gimbal angles are measured by variable capacitance transducers, which have a resolution approaching five arc seconds.

The entire star tracker is sealed within a glass dome, but since it is exposed to radiation, it must withstand a wide range of temperature conditions. Six star trackers are provided, looking along the plus and minus directions of the three axes. The maximum gimbal motion is ±45 degrees. Although only two trackers are sufficient to provide pointing information under ideal conditions, the increased number is provided to allow for occultation of guide stars by the Earth, maintenance of reference while shifting guide stars and redundancy for long life.

- **AOSO's Sun tracker**—"On *AOSO,* we feel the key element is the Sun tracker," said Mitchell. "So one of our Phase I efforts with Republic is to design, breadboard and actually build an engineering model."

The *AOSO* Sun tracker must have the following characteristics to fulfill its performance requirements, according to Adolph J. Cervenka, *AOSO* Project Manager, Goddard Space Flight Center:

—A pointing accuracy of 1 to 2 seconds of arc when oriented within a 40-arc-minute square centered on the Sun, and an accuracy of 1 minute of arc when outside this square and inside a 10-degree square centered on the Sun.

—Capability to track on command within the above 10-degree square.

—A tracking system bandpass of about 70 radians/sec.

—Compatibility with a simple, reliable programming and command system.

—A reliable and long-lived design.

He pointed out that work on various approaches to Sun tracker design led to the rotating-slab design, in which operation depends on the refraction of light through a slab of glass. If the index of refraction of the glass and its thickness are properly controlled, the angle of the light fom the Sun can be measured precisely by positioning the slab.

The slab is rotated until the sunlight passing through the glass nulls a photosensitive detector. A 20-arc-second rotation of the slab corresponds to a 1-arc-second angle of incidence of the sunlight.

An existing Baldwin digital encoder with an accuracy of 20 arc seconds will measure the slab position; this readout will be compared with the observatory reference variable to form the error signal for the control system. A servomotor will position the encoder and slab.

Two units, one for the pitch and another for the yaw axis, comprise the tracker. A most important feature of this design is that the axes of the two slabs are orthogonal. This permits commanding the Sun tracker in the same reference frame as the satellite, and considerably reduces the complexity of the pointing command system. ■

The Wide-Ranging Search for Tougher, Lighter Gyroscopes in Space

ANYTHING THAT MOVES, twists or shakes cyclically and at a relatively high frequency is being studied in a quickening search to devise long-lived, lightweight gyros with few or no moving parts, low or zero drift rates, and small power inputs for space applications.

The quest extends from using coherent light rays as in the laser gyro to exploiting the gyroscopic properties of atomic nuclei; from measuring the internal pressures generated in a rotating fluid to determining the motion of a vibrating piezoelectric cylinder acted on by external forces.

Laser Gyros

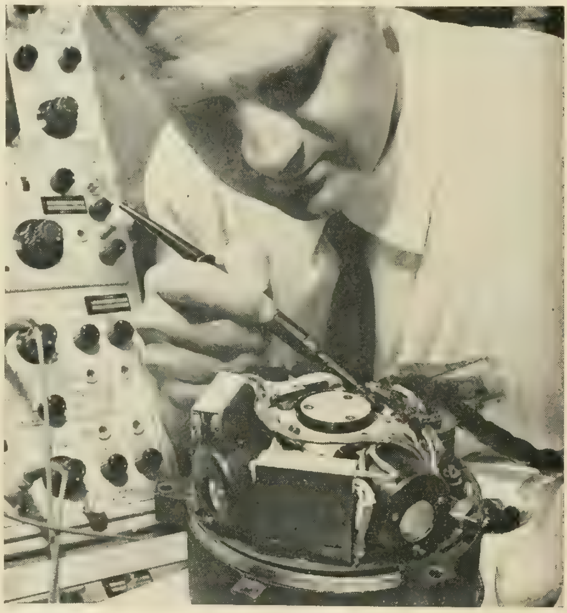
Several firms, some under Air Force Aeronautical Systems Div. sponsorship, are working toward development of laser gyros (M/R, Feb. 18, p. 24) as a means to improve on inertial system sensitivity and reliability and reduce cost.

Both General Precision, Inc. and Sperry Gyroscope Co. demonstrated systems of this type earlier this year.

GPI engineers believe these non-mechanical devices, though still in a very early design stage, may eventually measure angular position references with respect to inertial space, and exhibit resolution of less than ¼ arc second and drift rates less than five arc seconds daily.

• **Working principles**—The laser gyro is based essentially upon the constant speed of light, the fully coherent properties of laser light, and the ability to measure the very small frequency difference between light traveling along different path lengths.

One of the major economic advantages that may accrue to this sensor, Sperry engineers point out, is that it will operate as a strapped-down system, avoiding all the mechanical problems of conventional inertial platforms. Other linear acceleration errors associated with rotating mass systems are also eliminated. Sensor output is also basically digital, easing read-out.



FIRST RELEASED PHOTO of Honeywell airborne electrostatic gyro shows miniaturized optical pickoffs and vacuum pump.

As promising as lasers look, they will not become operational overnight. Available power for space use will demand much greater input/output efficiencies. With early work carried on using a variety of gases and wavelengths, there will now probably be a major attempt to develop solid-state CW systems possibly based on some of the recent GaAs lasering action work (M/R, Feb. 4, p. 21).

Research will be directed at new configurations and new media, both aimed at shrinking the size of the sensor. Use of different excitation methods and of ceramics rather than glass in the laser "ring," according to Sperry, may also improve performance considerably. Low noise photodetectors will also improve sensitivity.

GPI engineers believe a fully operational gas-type optical gyro—weighing less than 2 lbs. (probably using quartz for mirrors and tubes), occupying less than 30 cu. in., and requiring less than 10 watts power—can be developed by 1965.

Some experts say laser gyros are not gyros at all because they provide an output directly proportional to rate of rotation.

• **Bending the light**—The laser gyro consists of a reflecting system in which light is reflected around a closed path to return to its point of origin. A typical arrangement would be four mirrors located at the corners of a square, with a laser in one side of the square. Light from the laser can pass in either direction around the square, and the optical frequency at which the system oscillates depends on the path length around the square.

When the square is rotated, the light path in the direction of rotation is increased in length and the light path opposite to the direction of rotation is decreased. This means that the system can oscillate at two different optical frequencies.

If the forward and backward waves are mixed in a non-linear element such as a photomultiplier, a signal equal to the difference in frequency between the forward and backward paths is obtained. This difference frequency is proportional to the length of the loop and the angular rate of rotation.

For laboratory-size loops with a side of about two feet, the difference frequency is about 500 cycles per rad per second.

Unfortunately, this frequency is an extremely small fraction of the fundamental frequency of operation of the device (optical frequency). As a result, the two modes of oscillation tend to "pull" together to become a single mode of oscillation, and there seems to be a minimum frequency below which the system no longer functions.

So far, laboratory devices have been able to sense Earth rate.

Again, the laser equipment is bulky and unsuitable at present for use in space applications. Attempts to reduce the size of the system by reducing the dimensions of the square mean a reduction in sensitivity.

One way to increase path length while reducing size might be to use contra-wound helices of some sort.

Nuclear Gyros

The still-evolving nuclear gyro is a strong contender in the drive to reduce the mechanical complexities of measuring devices. These devices have no moving parts, are frictionless, and are reported to have a very high resistance to acceleration, vibration, and shock. Warm-up time is short, and life time is said to be long. Size, weight, and power requirements are said to be competitive with conventional gyros, with minimum shielding required.

Nuclear gyros are based on the principle that if the atomic nuclei of a material can be aligned, they will remain aligned when the material is rotated. In the absence of a magnetic field, these nuclei will precess when the material is rotated and will function as a two-axis gyro.

A magnetic field is always present. The magnetic spin moments of the nuclei and their precession interact with this field to provide a signal that can be measured by a microwave absorption technique or some other method.

If the magnetic field is constant, the precession frequency of the nuclei will be a function of the angular rate of the device. This frequency is called the Larmor frequency and is a direct function of the angular rate and the magnetic field strength.

- **Magnetic sensitivity high**—Unfortunately the sensitivity of the device to magnetic fields is very high. Small fractional variations in the Earth's field will cause a large variation in precession frequency. Techniques for achieving a constant field strength are classified. One method that is being tried is use of superconducting shielding. Reduction of stray fields to the level of 10^{-12} Gauss is required, and this has not been done yet.

Present nuclear gyros are capable of detecting Earth rate.

Use of such techniques as cryogenic shielding make the device cumbersome. Considerable ingenuity will be needed to make the device suitable for spacecraft use. Although the interplanetary field is low, considerable variations in

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Advanced Research, Technology and Development

Issue Date
November 25
1963

Advertising Closes
November 11
1963

Projects Gemini and Apollo are well under way. The National Aeronautics and Space Administration is currently planning future projects like the orbiting space station, lunar base, manned Mars expedition, unmanned exploration of the Sun and the distant planets, and detailed investigation of Earth's environment.

M/R's Third Annual National Aeronautics and Space Administration issue will be a 100-page report covering advanced research, technology and development requirements for these programs.

hird annual NASA issue

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5. Directory of Key NASA Officials

Name ☐ Job Title ☐ Room and Telephone Numbers

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this field occur and the nuclear gyro would have to be adequately shielded from these.

Development of working research models of nuclear gyroscopes has been achieved recently by General Precision, Inc., and Republic Aviation Corp. Work in this area is supported by AF and Navy.

In the GPI design, the sensor obtains rotational information from an ensemble of atomic nuclei using magnetic resonance techniques. GPI scientists report they have adopted an operating principle that involves simultaneous observation of the magnetic resonance signals of two types of nuclei in vapor in the same magnetic field, with signal phase comparison yielding rotation data. The signals are observed as the outputs of an oscillator controlled by the nuclear resonances. Atomic nuclei in the vapor are oriented and monitored by optical means.

The Republic device (M/R, Aug. 13, p. 10) relies upon the inherent spin and associated magnetic movements of protons and electrons. The protons' resistance to turn, despite the rotation of their encompassing magnetic field, generates an electric current which basically reflects the vehicular direction change.

Fluid Rotor Gyros

The no-moving-part fluid gyro uses a ball of fluid that may be spun in any one of about a dozen ways. Readout is by sensing pressures in the fluid, that is, particle effects are used instead of solid body effects. Various firms are working on this, including Sperry, Autonetics, Lear, and Kearfott.

In the medium size category, this type of gyro is less than an order of magnitude removed from the accuracy of the same size conventional gyro. It is said to be much more reliable and cheaper to build.

Development of fluid (either liquid or gas) gyros for guidance and control systems also appears to hold promise as another no-moving-part approach to the problem.

- **Honeywell development**—As evidence of the possibilities, a group of Minneapolis-Honeywell engineers was recently cited for "outstanding achievement" by the AF's System Command for development of an all-fluid-control system that essentially uses fluid control mechanics without need for any moving parts (no pistons or valves) or electronic components. The technique is quite simple, and the absence of electronics is a very significant anti-radiation damage factor.

Honeywell has already developed a fluid-rate sensor to perform gyroscopic functions: measuring the disturbance caused by gyro rotation on a fluid flow. However, some observers note that relatively slow-moving fluid-type signals, in comparison to electronic devices, may limit fluid gyro guidance application. For control systems, however, it is judged to be quite significant.

Gimballess IMU's

At the recent American Institute of Aeronautics and Astronautics' Conference on Guidance and Control, two Massachusetts Institute of Technology engineers suggested that the trend in reduction of the number of mechanical gimbals associated with guidance systems would probably lead to the eventual elimination of gimbals from inertial measurement units.

Advances in digital computer techniques and capacities, through new packaging, would make it possible, they reported, to replace the gimbals with computation capable of isolating analytically a coordinate frame from vehicle rotation, or which accounts in some other way for the fact that the coordinated frame in which the inertial instruments are operating is rotating with respect to inertial space. In essence, this would reduce the IMU to a grouping of body-mounted inertial instruments.

Other Gyros

Electrostatic system—A spinning sphere of material is supported in an electrostatic field. The performance of such a device is classified, from which it is reasonable to assume that they can measure considerably slower rates than Earth rates.

To obtain sufficiently high field strengths to support the sphere, a high potential difference has to be applied across a very narrow gap. This means that a high vacuum (10^{-8} to 10^{-10} torr) must be achieved to prevent breakdown across the gap. An advantage of this low vacuum is that friction losses are very low. Signal pick-off is a major problem.

- **Extensive development**—Much more money has been put into the development of the electrostatic gyro than into the magnetic or cryogenic types.

In a practical application of the electrostatic gyro, Honeywell is developing a complete experimental airborne navigation system suitable for laboratory and flight test, under a recent $1.8 million Air Force contract. Also, it will provide another system to the Navy for experimental use with the *Polaris* submarine Ships Inertial Navigation System (SINS). It will be employed to monitor SINS. It has one drawback, however. The Honeywell ESG cannot determine true vertical and must be employed with a supporting sensor subsystem.

The airborne system is described as consisting of a gimballed platform that incorporates two miniature electrostatic gyros, three pendulous pulse re-balance accelerometers, and a computer.

The Honeywell electrostatic gyro, having a hollow beryllium sphere as its only moving part, has been under development for several years, the company says. During operation, the gyro rotor is continuously suspended within a ceramic case by an electrostatic field. When operating speed is attained, the magnetic field is cut off and the rotor continues to spin. Data are obtained from the rotor by means of a miniaturized fiber optics pickoff.

Vibragyro—A solid-state gyro, developed by Westinghouse Electric Corp. for space use, is simply a solid thin-walled hollow cylinder, pressed from ceramic powder and suspended midway between its two open ends. A typical cylinder is half an inch long, half an inch in diameter, and takes less than a thousandth of a watt to drive.

The solid-state gyro substitutes back-and-forth radial motion of the cylinder for the rotary motion of a wheel. The radial motion is obtained by exciting the cylinder with a small high-frequency voltage.

Made from a material such as barium titanate, the cylinder can convert applied voltage into mechanical vibrations; and inversely, mechanical vibrations back into electricity.

When operating, the open ends of the gyro cylinder vibrate back and forth at 100,000 cps. Once the cylinder is vibrating, it detects any move to rotate it around its axis, and responds by adding a (right-angle) lengthwise twist to its motion, Westinghouse reports. This action produces the useful electrical signal that is picked off and amplified.

Vibrating reed—Here is an old type of gyro that might have a space future. It is light and consumes very little power, making it suitable for space applications. It can sense Earth rate, but could probably be improved by several orders of magnitude. Not much money is currently being spent on this type.

Crystal—This is possibly a variation of the vibrating-reed type gyro. Westinghouse is working on one, using sonar transmitting crystals.

Magnetic or Cryogenic—The rotor is supported by a magnetic field. A spherical rotor made of superconductive material is generally used. Pick-off is at audio frequencies and pick-off techniques are a major problem.

- **Future inertial gyros**—The chief aim of new systems may not necessarily be increased accuracy. They will offer very real benefits if they are more reliable and cheaper than present gyros. Present gyros are extremely expensive and there is a very real problem of whether the cost of increased accuracy in a missile (already very accurate) is worthwhile in the overall economics of the situation. ■

Key Contacts in NASA and Military

GOVERNMENT RESEARCH and development work on guidance and control systems—both within NASA and DOD—is scattered through many field centers and installations.

NASA's G&C development ultimately will be centered in the Electronics Research Center, if the Center receives final Congressional approval. Currently, this research work is headed by Dr. Albert J. Kelley, director of Electronics and Control in the space agency's office of Advanced Research and Technology. Portions of the actual R&D work are done at the various field centers.

The same situation is present in DOD, with overall direction of guidance and control systems in the Office of the Assistant Secretary of Defense for Research and Engineering.

G&C work peculiar to any service is handled at that service's own R&D centers.

A list of the principal people and centers controlling G&C development for the military and NASA follows.

NASA HEADQUARTERS
OFFICE OF ADVANCED RESEARCH & TECHNOLOGY
ELECTRONICS & CONTROL DIVISION

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H. D. Garner	Automatic Control Section

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Col. M. E. Esch	Chief, Mechanics Office

SPACE SYSTEMS DIVISION

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BALLISTIC SYSTEMS DIVISION

Lt. Col. Harold Croyts	Director, Guidance & Control

AERONAUTICAL SYSTEMS DIVISION

Col. Kenneth Dean	Chief, Navigation & Guidance Division, Avionics Laboratory

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Lt. Cdr. R. A. Hodnet	Head, Long-Range Anti-Air Warfare Branch
Cdr. Howard C. Hansen	Head, Short-Range Anti-Air Warfare Branch
Lt. Cdr. J. K. Keihner	Head, Phoenix Missile Branch
Lt. Cdr. R. W. Illgin	Head, Attack Missile Branch
Capt. W. F. O'Bryant	Director, Astronautics Division
Capt. J. R. Stinneman	Director, Measurements Satellite Division
Thomas F. Griffin	Programs Manager, Measurements Satellite Division
Cdr. F. M. Holmes	Head, Navigation Satellite Branch
Cdr. N. J. Stevenson	Director, Astro-Defense Division

NAVAL ORDNANCE LABORATORY

Roy Kogge	Chief, Fire Control & Guidance Division

NAVAL ORDNANCE TEST STATION

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M. M. Rodgers	Chief, Air-to-Surface Weapons Division
Charles Smith	Chief Air-to-Air Weapons Division
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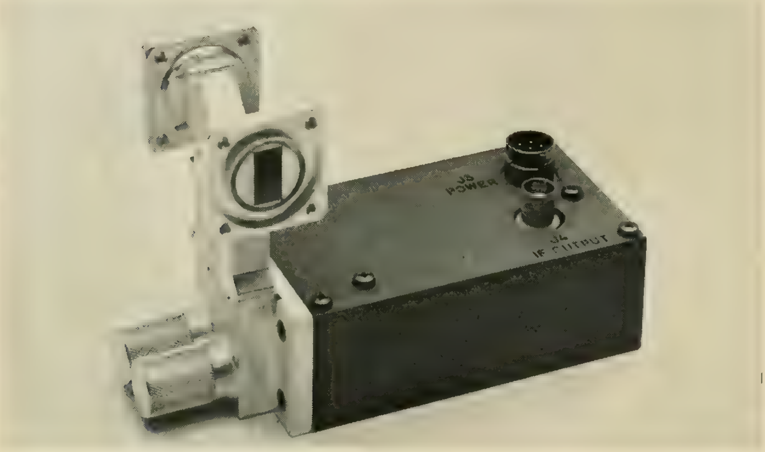
New Product of the Week: K-Band Preamplifiers



RHG Electronics Laboratory, Inc., is marketing a line of K-band mixer preamplifiers covering a range of 12 to 40 gc.

Germanium, silicon and vacuum tube preamplifiers provide IF center frequencies to 240 mc and bandwidths to 240 mc.

Assemblies feature premium crystals, mating power connector and test data. Complementary IF amplifiers are available to provide complete microwave receivers.

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Data Recording System

A Spectrophotometer Data Recording System that will automatically convert output data of any spectrophotometer to computer language is available from Datex Corp.

Designated the SDS-1, the system offers seven distinct modes of operation with punched paper or card punch output.

The unit provides recording transmittance, reflectance or absorbance on pre-selected variable increments of wave number or wave length. Additional modules can be added to the base system to provide readouts and visual displays.

The model may be used with any analytical instrument where readout of a variable is based upon coordinate values.

Circle No. 227 on Subscriber Service Card

Two-Axis Programmer

A self-contained programmer with two-axis programming applications is available from Nawide Machine Tool Div. of Nationwide Engineering Service, Inc.

Known as Model OPT-300 Optical Programmer, the device programs a range of two-axis numerically-controlled machine tools. Flexibility allows for long mass-production runs as well as for prototype or pilot runs.

The unit translates hole positions contained on a positive or negative photo, circuit board or art work, into punched and printed tape.

A full keyboard allows the operator to convert coordinate dimensions to punched tape. Normal programming speed is 15 to 20 holes per minute. Tape used is EIA standard, 1 in. wide, 8 channel. Electrical supply is 110 v, 60 cps.

Circle No. 228 on Subscriber Service Card

Digital Voltage-Divider

A thumbwheel switch that functions as a digital voltage divider is available from Engineered Electronics Co.

The Model 116 has 10 positions, 0 through 9, which permit the operator to select the desired decimal fraction of an applied reference voltage. A printed-circuit card extending from the back of the switch provides for the mounting of voltage-divider resistors. Provision is made for an additional scale-factor resistor.

Circle No. 229 on Subscriber Service Card

Heat-dissipating Tube Shield

A thermo-electric heat-dissipating tube shield has been introduced by Cool-Fin Electronics Corp. Called the CFT-9 Series, the new devices have tested cooling characteristics 33% below bare bulb temperatures. This represents cooling efficiencies up to 40% greater than has been available, according to Cool-Fin. The 20° C minimum surface temperature reduction required under MIL-S-9372C is easily met.

The higher cooling rate is produced through a radiating fin-type configuration. With the added expanse of cooling surface shown by this type of construction, approximataely 200% more effectiveness is gained over non-finned types. The shields are especially designed for Compactron tubes.

Shields are designed to fit all Compactron envelopes. Radiating fins are 3/16 in. wide. The entire shield adds only 3/8 in. to the diameter of the tube envelope. Maximum electrical and thermal conductivity is provided by tempered aluminum coated by an exclusively developed finish. Material conforms to specification QQ-A-561. MIL-C-5541 covers the finish. Units are furnished with or without tangs for grounding. Suitable complementary bases for mounting and grounding may be ordered.

Circle No. 230 on Subscriber Service Card

Time Delay Relay

Thermal Controls, Inc., is marketing the Model 700 Military Type Relay, designed primarily for military and missile applications and capable of surpassing present military specifications.

The unit is a rugged, expansion-type relay, able to withstand extreme shock and vibration and suitable to wide ranges of environment applications.

Operational time range is 10 to 180 sec. Tolerance is ±10% at rated voltage; acceleration is 50 g's. Predicted life of the unit is 100,000 operations.

Circle No. 231 on Subscriber Service Card

Stroboscope

Amstro Corp. has available the Model S-1 Electrical Stroboscope, which can provide direct measurements of speeds without any contact with the moving parts.

The 4-lb. device has an accuracy of ±1% of rpm reading. Range is 200 to 16,000 rpm. Harmonic principle allows readings of over 100,000 rpm.

Circle No. 232 on Subscriber Service Card

Sub-Miniature Oscillator

The Instrument Div. of Scionics Corp. is marketing the Model VCO-103 voltage-controlled sub-carrier oscillator, designed to perform accurately over a wide temperature range.

Temperature characteristics of the unit are 1% of DBW frequency shift per 100°F from −65° to 200°F. All standard IRIG channels are available.

The device has an input impedance of 500K ohms (channels 1 to 18) and 250K ohms (channels A to E). Output distortion is less than 0.5% at center frequency. The unit is encapsulated in a metal filled epoxy case for electrical shielding. Dimensions are 1.6 x 1.3 x 0.75 in.

Circle No. 233 on Subscriber Service Card

Voltage Regulator

A 1-KVA model of the Solatron voltage regulator has been developed by Sola Electric Co., a division of Basic Products Corp. It was designed for use where size and weight are critical.

The solid-state unit is one-fourth the size of previous Solatron regulators. It measures 12 x 6 x 6¼ in. and weighs approximately 35 lbs.

The device operates at an efficiency of 93%. Regulation is ±0.25% at rated output settings and ±1.0% at other adjusted outputs. Frequency range is 60 cps ±5%. Other specifications: input—108 to 132 v, single phase, 57 to 63 cps; regulated output—120 v nominal, 1,000 va; nominal load range—0 to 8.4 amps.

Circle No. 234 on Subscriber Service Card

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- **FM, AM, Phase-lock and Phase demodulators**
- **Plug-in pre-detection recording converters**

Already used in more than a dozen unmanned earth orbit satellite programs, the Model TMR-6 telemetry receiver from Defense Electronics, Inc. has no true equivalent in its field.

The completely-modular unit has been specially-designed by DEI to accept inexpensive plug-in sub-assemblies . . . seven RF tuning heads . . . nine IF amplifiers and four demodulators . . . to cover all presently-assigned frequencies in the VHF/UHF spectrum.

The TMR-6 features crystal control of both oscillators, extremely low noise figures and can be adapted for use in PM systems by means of a phase-locked loop around the entire receiver. It is capable of tracking any frequency change introduced by Doppler shift, transmission and reception instabilities up to 0.007 per cent of the received frequency.

This versatile, low-cost receiver also accepts plug-in modules for pre-detection recording of either AM or FM with existing stationary head video tape recorders.

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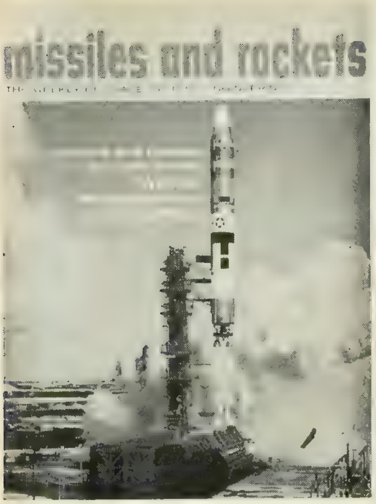
Circle No. 33 on Subscriber Service Card



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Half-size Crystal Can Relay

A half-size crystal can relay suited for printed circuit and high environmental applications has been announced by Guardian Electric Manufacturing Co.

Designated the GO series relay, the device is designed for reliability in the area of low level to 2 amp switching. It operates at temperatures from −65 to 125°C and meets all requirements of MIL-R-5757D.

The unit has 0.2-in. grid terminal spacings and is interchangeable with most standard crystal can relays. Standard specifications include: contact arrangement 2PDT; dc resistive; life (at rated load) 100,000 cycles; coil data 6 to 26.5v dc nominal; special coils obtainable to 24 K. Typical oeprating time is 0.0004 sec. maximum. Typical release time is 0.0002 sec. maximum.

Custom units are available in 16 designs, providing variations of terminal types, mountings, contact ratings, coil-operating voltages and either ac or dc designs.

Circle No. 235 on Subscriber Service Card

Trimming Potentiometers

Spectrol Electronics Corp. is marketing the Model 94 and the Model 82, trimming potentiometers.

Model 94 is a rectangular trimmer with a metal wiper and mechanical endstops with overtravel clutch. Standard resistance range is 50 ohms to 20 K, ±10%; operating temperature is −65° to 105°C; power rating is ½ watt at 50°C. The unit is available with insulated stranded leads, printed circuit pins or solder hooks. Weight is 4.5 grams.

Model 82 is a round trimmer in a TO-9 transistor type case. Single-turn adjustment allows rapid setting with high accuracy. Resistance range is 50 ohms to 50 K, ±10%; operating temperature is −65° to 105°C; power rating is 0.5 watt at 50°C; weight is one gram.

Circle No. 236 on Subscriber Service Card

Frequency/Deviation Meter

A combination frequency meter, deviation meter and signal generator, the FM-9, is available from Gertsch Products, Inc.

With all solid-state circuitry, the package measures 8 x 12 x 12 in. The instrument features direct digital reading of allocated channels in the 150 to 162-mc band. It measures and generates channels in the 450 to 486-mc band, utilizing third harmonics. Accuracy is 0.0002% (2 ppm).

Generated outputs are less than 0.5 microvolts for receiver sensitivity checks. Outputs of 400 to 500 kc are also available for IF alignment. As a deviation meter, the instrument measures peak FM deviations in two full-scale ranges—5 and 15 kc.

The unit operates from a 115/230-v ac line, a 12-v dc battery or an optional, rechargeable battery pack.

Circle No. 237 on Subscriber Service Card

Miniature FM Discriminator

Genisco Instruments, a division of Genisco, Inc., has available a miniaturized FM subcarrier discriminator designed to resolve weight and space problems while providing accurate acquisition of signal information.

Designated the Model A-135, the device features printed circuit board construction and measures 3.5 x 0.9 x 10 in.

The device has a center frequency range in all IRIG channels, with other channels available on order. It has an input dynamic range of 40 mv to 10 v RMS, without gain adjustment. Eighteen units may be connected in parallel with an input impedance of 200 k ohms minimum.

Other specifications: output—±2.5 v into 600-ohm load; linearity, ±0.5% of bandwidth; frequency deviation, standard IRIG ±7.5% or ±15%.

Circle No. 238 on Subscriber Service Card

Digital Voltmeter

An integrating digital voltmeter, the Model 510, is being marketed by Vidar Corp.

The device has a range of 10 mv to 1,000 v in six decade steps with 300% over-ranging on all but the 1,000-v range. The input is completely guarded and isolated from the powerline ground, with more than 130 db common mode rejection at all frequencies, including dc. Input impedence is greater than 10 megohms. A binary coded output with full storage is provided.

Circle No. 239 on Subscriber Service Card

Radiation-Resistant Headers

A line of radiation resistant connectors and headers that operate from —320° to 1,200°F is available from Statham Instruments, Inc.

Typical specifications include a thermal neutron capture cross section of less than 1×10^{-24} cm^2 and a leak rate of less than 2×10^{-9} cc He/sec. The pressure seal withstands greater than 10,000 psi. Electrical insulation is more than 400,000 megohms at 1,000v dc.

The units are unaffected by aqua regia, nitric acid, sulfuric acid and hydrochloric acid, in all concentrations.

Circle No. 240 on Subscriber Service Card

Synchronizing Programmer

Digital Products Div. of Hyperion Industries, Inc., is marketing a Precision Synchronization Programmer, the Model HI-408.

The unit provides 10 discrete separate relay outputs, programmed at separate time-of-day counts to the nearest millisecond. Time displayed may be automatically synchronized with radio station WWV. Pulse repetition rates of 1,000, 100, 10 and 1 pps, 1/10 sec., 1 per minute, 1 per hour, 1 per 10 hours and 1 per 24 hours are provided.

Input power is 105 to 125v, 50 to 400 cps. Power consumption is approximately 75 watts.

Circle No. 241 on Subscriber Service Card

Photo-resistor

The Industrial Components Div. of Raytheon Co. has developed a cadmium selenide photo-resistor that can change resistance over a range of 1-million ohms in 0.0005 sec.

The Model EM-1502 spans wave lengths from 5,000 to 12,000 angstrom units, with a peaking at 6,950 Å, making it applicable to infrared detection as well as visible light monitoring. The unit can be operated in circuits with voltages as high as 200v.

The device is packaged in a TO-5 metal case and weighs 1.25 grams.

Circle No. 242 on Subscriber Service Card

Frequency Multiplier

Communications Electronics, Inc., is offering the Type SFM-1 standard frequency multiplier.

The unit takes a 1-mc standard signal from a highly stable source and multiplies the signal up to 50, 100, 500, and 1,000 mc.

All outputs are available simultaneously and provide a minimum of lv RMS across a 50-ohm load. Input and output impedances are 50 ohms. The device operates from 115v, 50 to 400 cycles with power consumption of 20 watts.

Circle No. 253 on Subscriber Service Card

THE NATIVES ARE FRIENDLY

IN

WEST VIRGINIA

The character above on the right is a cartoonist's (and TV scriptwriter's) notion of a West Virginian. Actually, only the smile and the warm handshake are real. Oh, once in a while when we're walking the hills we might pick up and chew on a stem of wild grass. Promotes thinking, cuts down on nicotine consumption.

But if you think West Virginians live in shacks and talk like the McCoys, consider these facts about Charleston, where Union Carbide has its Technical Center: income per family among the nation's highest (number four, among all cities, last time we looked) . . . an excellent school system (the thousands of engineers, scientists, and technicians living hereabouts wouldn't **allow** it otherwise) . . . our own citizen-staffed symphony, light opera guild, drama company and community chorus (if culture isn't your cup of tea, the backyard deepbreathing is unexcelled).

Union Carbide has established an advanced position with its HYBALINE® liquid fuels and its CARBITRON® solid grains. (Basic patents are under U. S. patent secrecy orders.) For inventive minds, this is a chance to apply past solid or liquid fuels experience to novel and unusual concepts . . . an opportunity to work for a company willing to support creative projects with its own funds.

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Organo-Metallic Chemist—Solid or Liquid Fuels Exploration of high energy fuels. Formulation of new high energy ingredients. Testing to establish stability, compatibility and sensitivity. Development of safe handling techniques. Will work with hydrides and hydrogen-containing compounds of the light, energetic metals and with ligands, chelates and coordination compounds. BS, MS or PhD Chemist or ChE.

Theoretical Ballistics Engineer (Chemist or Physicist) PhD (or equivalent experience) in ChE, physical chemistry, aero eng., or physics with a strong theoretical background in the fields of transport phenomenon and kinetics. Know theoretical aspects of internal ballistics; capable of performing theoretical analyses of the combustion of solid propellants. Will design experiments and analyze results of ballistics data.

Thermodynamics Engineer (Chemist or Physicist) PhD (or equivalent experience) in ChE, pet. chem., or physics, experience in thermodynamics and the estimation of properties from molecular structure. Will furnish consulting service to the Rocket Propulsion project in thermodynamics and theoretical performance calculations.

Data Reduction Engineer (or Mathematician) BS degree with computer programming experience in rocket propulsion field. Responsible for reduction of solid propellant static test data to ballistic parameters. Assists in the design of future digital data acquisition systems.

Propellant Chemist—Polymers and Binders MS or PhD degree in organic chemistry with a major in polymer chemistry. Investigate and develop binders, bonding agents and liners for advanced solid propellant compositions. Theoretical analysis, synthesis of new materials, propellant formulation, stabilization and decomposition studies. Experience in polymers is required; background in plastics formulation is desirable.

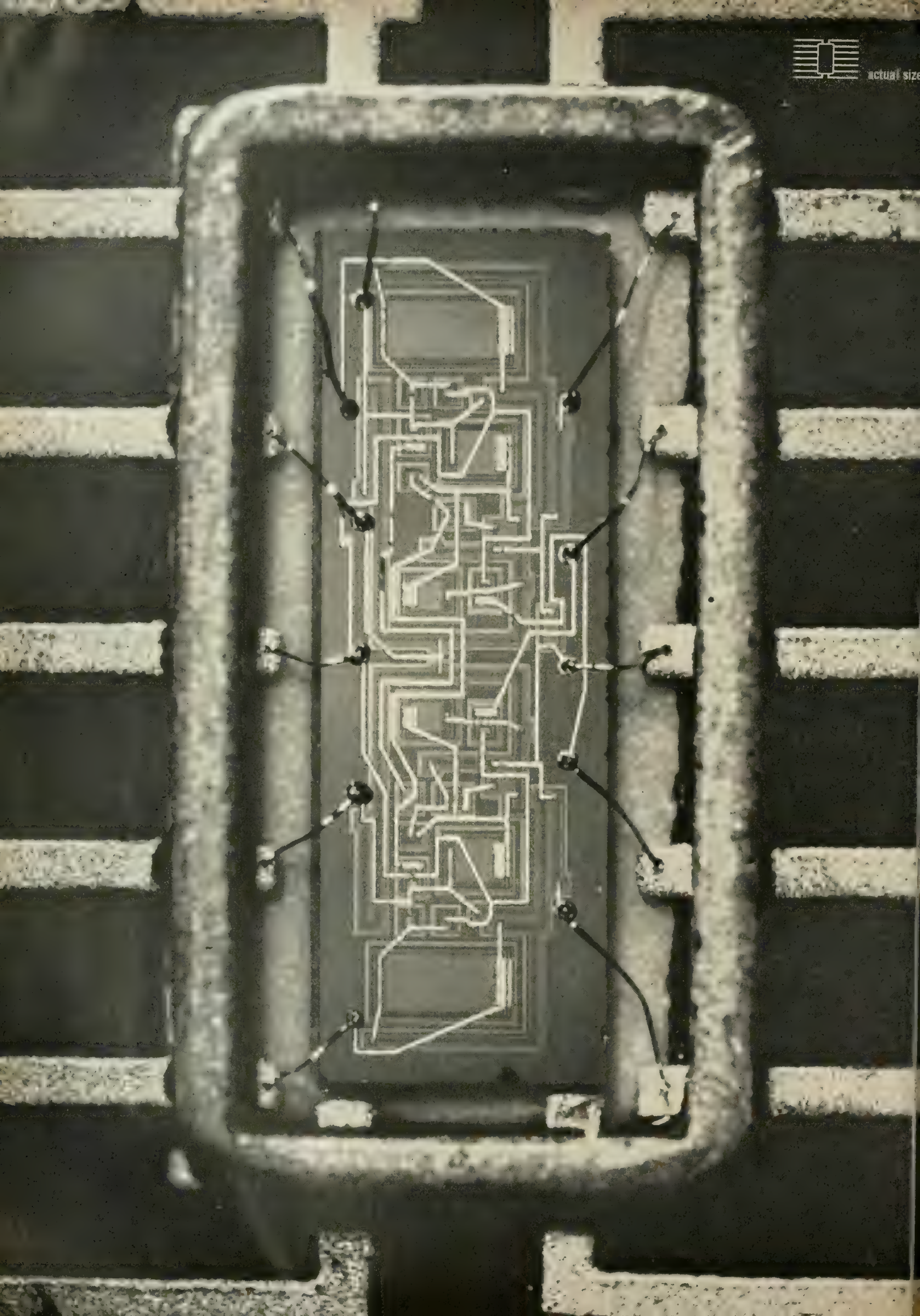
Chemist—Oxidizers and Liquid Propellants To synthesize and develop new oxidizers for various liquid propellant applications and for use with Union Carbide's HYBALINE® fuels. PhD (or equivalent experience).

Process Development Engineers—No Rocket Exp. Req'd. Two to 5-years' experience in Process Development of reactive, organic chemicals. Will develop feasible processes for the manufacture of new chemicals. Study theoretical aspects and variables for new processes using bench-scale and pilot-scale equipment through kinetic and thermodynamic considerations of the reactions. BS degree in ChE, ME.

Recent Graduates—ChE Good scholastic record plus zero to 4 years' experience. For production or research positions not in the rocket field. Qualified applicants will receive equal opportunities; U. S. citizenship is a requirement.

UNION CARBIDE

Circle No. 41 on Subscriber Service Card


actual size

This molecular circuit used in the Improved Minuteman

This is a photomicrograph (enlarged 37 times) of a molecular flip flop circuit which is used in the U.S. Air Force's Improved Minuteman Missile System. The circuit is equivalent to 40 discrete active and passive components and was designed by Autonetics Division of North American Aviation, Inc. It was molecularized and is being produced by Westinghouse Molecular Electronics Division. Westinghouse has available the industry's broadest line of standard digital and linear circuits. The digital blocks are fully compatible and can be interconnected to perform any digital function. The linear line covers all functions and has a useful operating range up to 30 megacycles. Also, for special requirements, Westinghouse has the proved ability to translate virtually any customer circuit design into molecular blocks. Call your local Westinghouse Representative (listed below) or contact the Westinghouse Molecular Electronics Division Headquarters, P. O. Box 1836, Elkridge, Maryland (301) 796-3666. You can be sure . . . if it's Westinghouse.

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Circle No. 22 on Subscriber Service Card

Infrared Detectors

Infrared Industries, Inc., has available indium antimonide infrared detectors in three models.

Two dewar mounted versions are offered for cooled operation at liquid nitrogen and CO_2 temperatures. For ambient use, an uncooled photoelectromagnetic detector is offered. A —78°C Peltier-cooled package has also been developed.

The cooled units have peak D Star values on the order of 2×10^{10} with wavelength response near 6 microns and one microsecond time constants.

The PEM package provides room temperature D Star values of 3×10^{7} out to approximately 7 microns. Time constant is rated at 1 microsecond, with resistance as low as 5 ohms. Several types of IR transmitting windows are available.

Circle No. 243 on Subscriber Service Card

Ultra-stable Oscillator

A 1.0-mc oscillator for use in vehicular or aeronautical single side band and data transmission equipment is being marketed by The James Knights Co.

Designated the JKTO-81, the device is designed to operate under extra-rough conditions. It provides a daily aging stability performance of 5×10^{-9} or better after ten days initial operation.

Maximum power required at —40°C is 7.25 watts from a nominal 24v dc source. Sine wave or square wave signal output is available.

Circle No. 244 on Subscriber Service Card

Intravalometer

Abrams Instrument Corp. has developed the Model BD-11 intervalometer, which supplies a repeating output pulse with adjustable interval from 0.2 to 30.4 seconds in 0.1-second increments.

Accuracy is ±50 milliseconds or 1% of setting. Output pulse duration is 75 milliseconds ±10%. Voltage requirements are 115v, 400 cps ±1 cycle for motor, and 25 to 30v dc for clutch and output pulse.

Operating temperature is 0° to 185°F. Vibration resistance is 5 to 55 cps 0.036 DA and 55 to 500 cps 5 g's, operating.

The device meets MIL-E-5272 specifications and has a service life of 3,000 hours.

Circle No. 245 on Subscriber Service Card

Metallized Capacitors

A line of metallized polycarbonate film, hermetically sealed capacitors, operating within the temperature range of —55° to 125°C, has been developed by Dearborn Electronic Laboratories, Inc.

Designated the Deltafilm "LP" Series, the units are available at ratings of 100, 200, 300, 400 and 600v dc. Capacitance values range from 0.01 through 5.0 mfd. At 25°C, the dissipation factor is less than 0.5%; insulation resistance 100,000 megohm-microfarads, minimum. Moisture and temperature tests meet MIL-C-19978B specifications.

Circle No. 246 on Subscriber Service Card

Heterodyne Voltmeter

B&K Instruments, Inc., is marketing the Model 2005 Heterodyne Voltmeter for use in equipment with controlled RF frequencies.

Frequency range of the device is 20 kc to 30 mc; accuracy is 2% ±2 kc; voltage accuracy is ±0.5 db. Voltage ranges (full scale) are 15, 150, 1,500 microvolts, 15 and 150 millivolts. By using the capacitive attenuator, the voltage range extends to 1.5 and 15v. Input impedance is 5 megohms at 100 kc and 90,000 ohms at 30 mc, paralleled by 5.5 pf. With the attenuator, impedance exceeds 1,000 megohms paralleled by 2 pf. The system need not be recalibrated with each frequency change.

Circle No. 247 on Subscriber Service Card

Coaxial Isolator

A miniature S-band coaxial internal magnet isolator, suited to low power applications, is being marketed by Micro-Radionics, Inc.

Designated the Model C-F-IS-S-006-3437, the device operates over a 2.7 to 2.9-gc bandwidth. Type N connectors are furnished; other types may be specified.

Specifications—Isolation, 20 db minimum; insertion, 1.0 db maximum; VSWR, 1.2 maximum; power, 10 watts CW and 10 kw peak; dimensions, 3 7/16 in long, ¾ in. diameter; weight, 3 ounces.

Circle No. 248 on Subscriber Service Card

Gallium Arsenide Varactor

A Gallium Arsenide varactor with a 320-gc minimum cut-off frequency at —6v is available from Micro State Electronics Corp.

The Model MS4107, designed primarily for S, C and X-band parametric amplifiers, has a junction capacitance at zero bias from 0.2 to 0.5 pf. Capacitance tolerances as low as ±5% are available for single units or matched pairs.

Coaxial pin packages have a typical case capacitance of 0.18 pf, a typical series inductance of 0.4 mμh and can be operated down to liquid helium temperature (4°K).

Circle No. 249 on Subscriber Service Card

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PRODUCTION ENGINEER—ROCKET ASSEMBLY

To provide technical support required by Rocket Assembly in areas of methods, tooling, fixtures, and equipment; detailed process studies and design work would be provided through coordination with technical and engineering operations. Responsibilities include manufacturing procedural requirements, acquisition, design and acceptance of tooling, fixtures and equipment; review contracts, drawings and specifications; provide engineers with manufacturing technical systems; assist in creation of cost estimates; review and supervise assembly personnel on assigned production tasks or programs. B.S. mechanical engineering with up to six years experience in field closely related to manufacturing and assembly techniques.

TEST ENGINEER

To plan and design test programs for rocket propulsion systems; prepare schedules and coordinate program to meet schedules; analyze test results and prepare test reports; design mechanical components for measurement systems; plan and coordinate environmental test programs; keep abreast of field of testing and rocket propulsion. B.S., M.S. mechanical engineering or physics with minimum of three years experience, preferably in rocket propulsion field.

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AIR FORCE

$3,000,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research and development on large solid-propellant motors.

$1,900,000—**Marquardt Corp.**, Van Nuys, Calif., for work on a classified project.

$1,894,000—**Radio Corp. of America**, New York, to make radar test sets.

$1,600,000—**Fischbach & Moore, Inc.**, to design, fabricate, install and check out complete instrumentation and thrust measuring systems for solid propellant rocket engines.

$1,170,000—**United Aircraft Corp.**, East Hartford, Conn., for work on the stellar inertial guidance system at Farmington, Conn.

$735,375—**Canadian Commercial Corp.**, St. Laurent, Quebec, Canada, for overhaul and maintenance of BMEWS/RCS equipment.

$535,000—**Computer Instruments Corp.**, Hempstead, N.Y., for precision film Potentiometers and commutators for low-level radar altitude systems.

$491,490—**Steppar Motors Div., Dynalectron Corp.**, Gardena, Calif., for a stepping switch applicable to AN/ALE-20 electronic countermeasures dispensing set.

$131,000—**Joe Dougherty Construction Co.**, for alteration to missile launch facilities at Lincoln AFB, Nebraska.

$90,000—**Cubic Corp.**, San Diego, Calif., for study and analysis in the field of radio interference.

$59,797—**Baldwin Electronics, Inc.**, Little Rock, Ark., for fabrication of T361 telemeter components and assemblies.

P. R. Mallory & Co., Inc., for a study of ultra-high vacuum sputtering (undisclosed amount).

ARMY

$27,700,000—**Martin Co.**, Orlando, Fla., for industrial engineering services on the *Pershing* weapon system.

$15,432,059—**Hughes Aircraft Co.**, Culver City, Calif., for continued research and development on the *TOW* antitank missile system.

$7,916,969—**Western Electric Co.**, for production of *Nike-Hercules* missile guidance sections at Greensboro, N.C.

$5,250,000—**General Dynamics Corp.**, to make vehicular radio sets.

$2,200,000—**Colby Crane & Manufacturing Co.**, Seattle, to supply three bridge cranes for use in assembling *Saturn* Moon rockets and mating them with the *Apollo* spacecraft.

$1,000,000—**Instrument Corp.**, Melbourne, Fla., for unspecified electronic equipment.

$700,000—**Space-General Corp.**, El Monte, Calif., for development of an automated air sampling device capable of rapidly detecting and identifying micro-organisms and examination of recent advances to determine a new approach to micro-organism detection methods.

$633,600—**Martin Co.**, Orlando, Fla., to provide personnel support at BIRDIE and Missile Master electronic air defense coordination sites.

$144,300—**Raytheon Co.**, Andover, Mass., for stabilized magnetron assemblies for the *Hawk* missile.

NAVY

$14,900,000—**Goodyear Aerospace Corp.**, Akron, Ohio, for conversion of earlier letter contract for *Subroc* missiles.

$4,800,000—**Northern Ordnance, Inc.**, Minneapolis, Minn., for long lead-time items for MK 13, MOD 1 and 2 guided missile launching systems.

$3,777,946—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for *Polaris* missile motors.

$1,600,000—GPL Div., **General Precision, Inc.**, Pleasantville, N.Y., for production of radar navigation systems.

NASA

$766,132—**Rantec Corp.**, Calabasas, Calif., for a Cassegrain feed system for an 85-ft. diameter antenna.

$276,500—**Perkin Elmer Corp.**, Norwalk, Conn., for five *Aerobee* rocket camera and experimental instrument packages.

$155,500—**Dynatronics, Inc.**, Orlando, Fla., for pulse code modulation signal conditioners.

$72,970—**Spaceflight Programs Office, Avco Corp.**, Tulsa, Okla., to supply a laboratory space environment chamber for use with an Instron tensile testing machine to simulate the extreme vacuum conditions of space.

$85,838—**SKG Corp.**, Anaheim, Calif., for telemetry equipment.

$59,043—**ITA Electronics Corp.**, Landdowne, Pa., for ultra-high-frequency satellite interrogation transmitters and control consoles.

$30,344—**Sanborn Co.**, Rockville, Md., for a recording system and related items.

INDUSTRY

$35,000,000—**Goodyear Aerospace Corp., Arizona Div.**, from **McDonnell Aircraft Corp.**, St. Louis, for production of high-resolution radar units for use by the Air Force.

$1,800,000—**Electronic Communication, Inc.**, St. Petersburg, Fla., from **Radio Corp., of America**, New York, for lightweight solid-state mulitplex equipment for communication terminals.

$1,000,000—**Emerson Electric Manufacturing Co.**, St. Louis, from **Lockheed Aircraft Co.**, Sunnyvale, Calif., for design, development and production of 18 flight-line radar test sets.

$1,000,000—**Bryant Computer Productions**, Walled Lake, Mich., from **Collins Radio Co.**, Cedar Rapids, Ia., for 16 disc files for use with collins' communications and data processing system.

$1,000,000—**Beckman Instruments, Inc.**, Fullerton, Calif., from **North American Aviation, Inc.**, Downey, Calif., for equipment to monitor and record test data on *Apollo* command and service modules.

$250,000—**Emerson Electric Manufacturing Co.**, St. Louis, from **North American Aviation, Inc.**, Downey, Calif., for production of 3,000 tape magazines for use on automatic checkout equipment used in conjunction with *Hound Dog* missiles.

$150,000—**Display-Control Div., Luminator, Inc.**, Costa Mesa, Calif., from **Magnavox Co.**, Urbana, Ill., for production of FADAC computer input display matrix and manual keyboard.

$16,184—**Meridian Metalcraft, Inc.**, Whittier, Calif., from **Martin Co.**, Denver, for manufacture of a component for the telemetry system of the *Titan III* space launch vehicle.

Rucker Co., Oakland, Calif., from **North American Aviation, Inc.**, Downey, Calif., to supply specialized impulse drive air cylinder assemblies to be incorporated in the SNAPTRAN project (undisclosed amount).

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names in the news

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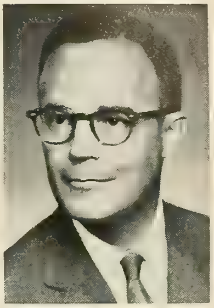
BURROWS

McCARTY


HUMPHREYS

Capt. George Humphreys (USN Ret.): Joined Benrus Watch Co., Inc., New York City, as administrative assistant to the president.

Charles J. O'Donnell: Appointed vice president of operations for the Kollsman Instrument Corp., Elmhurst, N.Y.

R. P. May: Elected vice president in charge of sales of Communication Electronics, Inc., Bethesda, Md.

I. T. Burney: Named manufacturing manager of the Westinghouse Cryogenic Systems Dept., Pittsburgh.

J. Erik Kalfus: Appointed vice president of Essex Electronics of Canada, Ltd., Trenton, Ontario.

W. J. Burrows: Appointed sales manager of Vapor Corp., Chicago.

Perry R. McCarty: Appointed treasurer of Beckman Instruments, Inc., Fullerton, Calif.

William D. Liittschwager: Appointed director of marketing for Cinerama Camera Corp., West Los Angeles.

Robert J. Stahl: Appointed manager of product planning for Sylvania Electric Products, Inc., New York City.

Welko E. Gasich: Vice president and assistant general manager-technical of Northrop Norair, Hawthorne, Calif., appointed to the Technical Board of the Society of Automotive Engineers.

Harvey G. Foster: Named director of security at General Telephone & Electronics Service Corp., New York City.

Donald S. Routh: Appointed sales manager, industrial control systems for Gulton Industries, Inc., Metuchen, N.J.

Dr. Walter Drobot: Joined Redel, Inc., Anaheim, Calif., a subsidiary of Curtis-Wright Corp., as director of research.

Floyd M. Cate: Appointed vice president of marketing at Cannon Electric Co., Los Angeles.

J. Wade Miller, Jr.: Appointed vice president-personnel and organization of the B. F. Goodrich Co., Los Angeles.

William C. Hoffart: Named director of operations control at Belock Instrument Corp., College Point, N.Y.

Bradford H. Vineall: Appointed quality assurance manager at Quantic Industries, Inc., San Carlos, Calif.

Dennis Vroom: Named senior mechanical engineer at Ortronix Inc., Orlando, Fla.

Chester W. Foster: Elected president and chief executive officer of Nordberg Manufacturing Co., Milwaukee. **James A. Friend** elected chairman of the board.

Edward P. Burns: Named chief of magnetics engineering at Manson Laboratories, Stamford, Conn.

Otis C. Ferrell: Named general manager of LFE Electronics, Boston.

Dr. O. Ray Price: Named chief engineer of TRW Electronics Microwave, Redondo Beach, Calif.

Sterge Demetriades: Named chief scientist-plasma physics for Rocket Power, Inc., Mesa, Ariz.

Dr. F. A. Coles, Jr.: Joined System Development Corp.'s planning staff, Santa Monica, Calif.

William P. Daley: Named vice president-finance at Aero Geo Astro Corp., Alexandria, Va.

Frank Thatcher: Joined Mica Corp.'s technical liaison staff and is responsible for customer technical relations and sales, Culver City, Calif.

Raymond R. Castiglione: Named manager of operations control for the defense marketing department of the St. Paul, Minn., operations of the UNIVAC Div. of Sperry Rand Corp.

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when and where

OCTOBER

IRE National Communications Symposium, Hotel Utica, Utica, N.Y., Oct. 7-9.

Corrosion of Military Equipment Committee Meeting, National Association of Corrosion Engineers, Admiral Semmes Hotel, Mobile, Ala., Oct. 8-9.

International Conference on Electromagnetic Relays, Tohoku University, Sendai, Japan, Oct. 8-11.

21st Annual Aerospace Electrical/Electronics Conference, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Oct. 9-11.

1963 General Conference, Federation Aeronautique Internationale, Mexico City, Oct. 12-21.

Materials Handling Conference, sponsored by ASME, AIEE and IRE, Chamberlain Hotel, Newport News, Va., Oct. 14-15.

Course on Space Power Systems, sponsored by George Washington University's College of General Studies, Airlie Center, Warrenton, Va., Oct. 14-15.

Advanced Purchasing and Subcontract Management Course, sponsored by the National Defense Education Institute, Charter House Hotel, Cambridge, Mass., Oct. 14-18.

Users of Automatic Information Display Equipment Annual Meeting, Carillon Hotel, Miami Beach, Oct. 15-17.

Eighth Symposium on Ballistic Missile and Space Technology, sponsored by Air Force Space Systems Div. and Aerospace Corp., Naval Training Center, San Diego, Calif. Oct. 15-18.

Second Annual Technical Colloquium, Society of American Value Engineers, Airport Marina Hotel, Los Angeles, Oct. 16.

AIAA/CASI RAeS Ninth Anglo-American Conference, Massachusetts Institute of Technology, Cambridge, Oct. 16-18.

American Vacuum Society, National Symposium on Vacuum Technology, Statler-Hilton Hotel, Boston, Oct. 16-18.

Fourth Annual One-Day Technical Symposium on Information Processing, University of Maryland, College Park, Oct. 17.

Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, IEEE, Emerson Hotel, Baltimore, Oct. 21-23.

American Society for Metals, Annual Meeting and National Metals/Materials Show and Exposition, Public Auditorium, Cleveland, Oct. 21-25.

23rd National Convention, Society for Nondestructive Testing, Pick-Carter Hotel, Cleveland, Oct. 21-25.

Ninth Conference on the Design of Experiments in Army Research, Development and Testing, Redstone Arsenal, Huntsville, Ala., Oct. 23-25 (by invitation only).

Human Factors Society Annual Meeting, Ricky's Hyatt House, Palo Alto, Calif., Oct. 23-25.

Optical Society of America Annual Meeting, Sherman House, Chicago, Oct. 23-25.

13th Annual Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 28-29.

National Electronics Conference, McCormick Place, Chicago, Oct 28-30.

Western States Section of the Combustion Institute Fall Meeting, University of Southern California, Los Angeles, Oct. 28-29.

IRE-PTGNS International Symposium on Plasma Phenomena and Measurement, El Cortez Hotel, San Diego, Oct. 29-Nov. 1.

IEEE 1963 Electron Devices Meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 1.

NOVEMBER

AIAA Vehicle Design and Propulsion Conference, Air Force Systems Command, Wright-Patterson Air Force Base, Dayton, Ohio, Nov. 4-6 (clasified).

IEEE Northeast Electronics Research and Engineering Meeting (NEREM), Commonwealth Armory/Somerset Hotel, Boston, Nov. 4-6.

Society for Experimental Stress Analysis Annual Meeting and Exposition, Statler Hilton Hotel, Boston, Nov. 6-8.

Magnetism and Magnetic Materials Conference, sponsored by AIEE, IRE and AIP, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., Nov. 11-15.

Fall Joint Computer Conference, sponsored by IRE, AIEE, Association for Computing Machinery and American Federation of Information Processing Societies, Las Vegas Convention Center, Las Vegas, Nov. 12-14.

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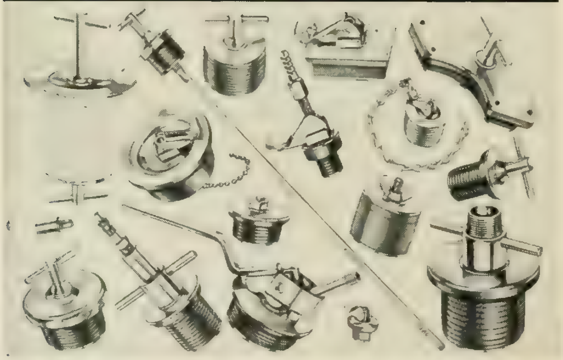

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The Reasonable Pace

IN THE LIGHT of President Kennedy's suggestion of a joint Soviet-American lunar expedition, it is imperative that Congress and the Administration understand the factors governing the pace of the U.S. manned lunar program.

Without question, the schedule for Project *Apollo*, particularly in regard to its funding, will come in for increasing discussion in the months ahead.

That could be foreseen even prior to President Kennedy's suggestion that the U.S. and the Soviet Union join in a venture to place an international expedition on the lunar surface. The President's offer to call off the lunar race will lead, almost certainly, to demands that funds for Project *Apollo* be reduced now that the urgency of competition with the Russians has been removed.

There are four things to consider in studying the pace of the lunar program—what we set out to do, the schedule established in order to do it, how far along the program is at this time, and how a stretchout in funding would affect the project.

President Kennedy made very clear in May, 1961, what this nation was undertaking in Project *Apollo*. He told Congress that the U.S. effort to land on the Moon in this decade was a project of the highest *national* significance. He said:

"It will not be one man going to the Moon. It will be an entire nation. For all of us must work to put him there."

Mr. Kennedy did not suggest that Project *Apollo* was being undertaken for several nations or that we were all working to put an American, a Russian, a Frenchman or a Briton on the Moon. It was presented as an American project, drawing on the resources of the entire American people, and it should remain so. What we set out to do is clear enough.

That brings forward the question of the schedule. Even some scientists who favor an eventual expedition to the Moon have suggested that perhaps we are embarking on the project prematurely. If the Administration is to continue Project *Apollo* as a joint venture with the Soviet Union rather than a national project, this view that competition with Russia drove us into the undertaking too early will be put forward even more vigorously. With the urgency of a race removed, it will be suggested that perhaps we can proceed at a more reasonable pace which will provide greater certainty of ultimate success.

Perhaps the best answer to this comes from Harrison Storms, president of the Space and Information Systems Division of North American Aviation, prime contractor on the *Apollo* program.

"When is soon enough?" he asks. "I don't see anything blocking us now."

In the view of Storms and other engineers on the project, the time to proceed is when you have the capability.

"What are you waiting for if you wait longer?" he asks. "I've got sufficient information now to proceed in an orderly manner."

It should be emphasized that *Apollo* is not a "crash" program. It is on an urgent but normal six-to-eight-year technical development cycle.

This does not mean that all the problems facing the *Apollo* team have been solved. But it does mean that nothing has to be invented in order to place an American expedition on the Moon. Some items of hardware still must be developed, but this is a problem of engineering the known, not of inventing the unknown.

We now possess the capability of landing Americans on the Moon in this decade.

How far have we progressed in turning that capability into a fact? It is not generally realized, but Project *Apollo* already is passing its peak effort in regard to funding and manpower.

In another six to eight months, the peak activity of Project *Apollo* will begin to slack off in the industry. Already, engineering drawings are being made, tests are being carried out, flight hardware now is visible on the factory floor. Concrete is being poured at Cape Canaveral, Santa Susana, the Mississippi Test Facility and elsewhere for the test stands and launch pads of Project *Apollo*.

The project is well along and its engineers are confident that the goal of a U.S. lunar landing in this decade will be met on the present schedules.

WHAT EFFECT, then, would a reduction in funds have on the program? Can an economy-minded Congress and Administration save money by stretching out the pace of Project *Apollo*? The answer is a flat and emphatic no. A stretchout in funds, coming at the peak of the effort, will have two distinct effects—it will increase the cost of the program and at the same time reduce its chances of success.

"If you put it off, it will cost more money," Harrison Storms states emphatically. "You must have the level of effort capable of developing the systems to do the job. If you go below that level, it costs money."

This is amply borne out by earlier experience of erratic direction in some of our large military programs, including North American's own B-70.

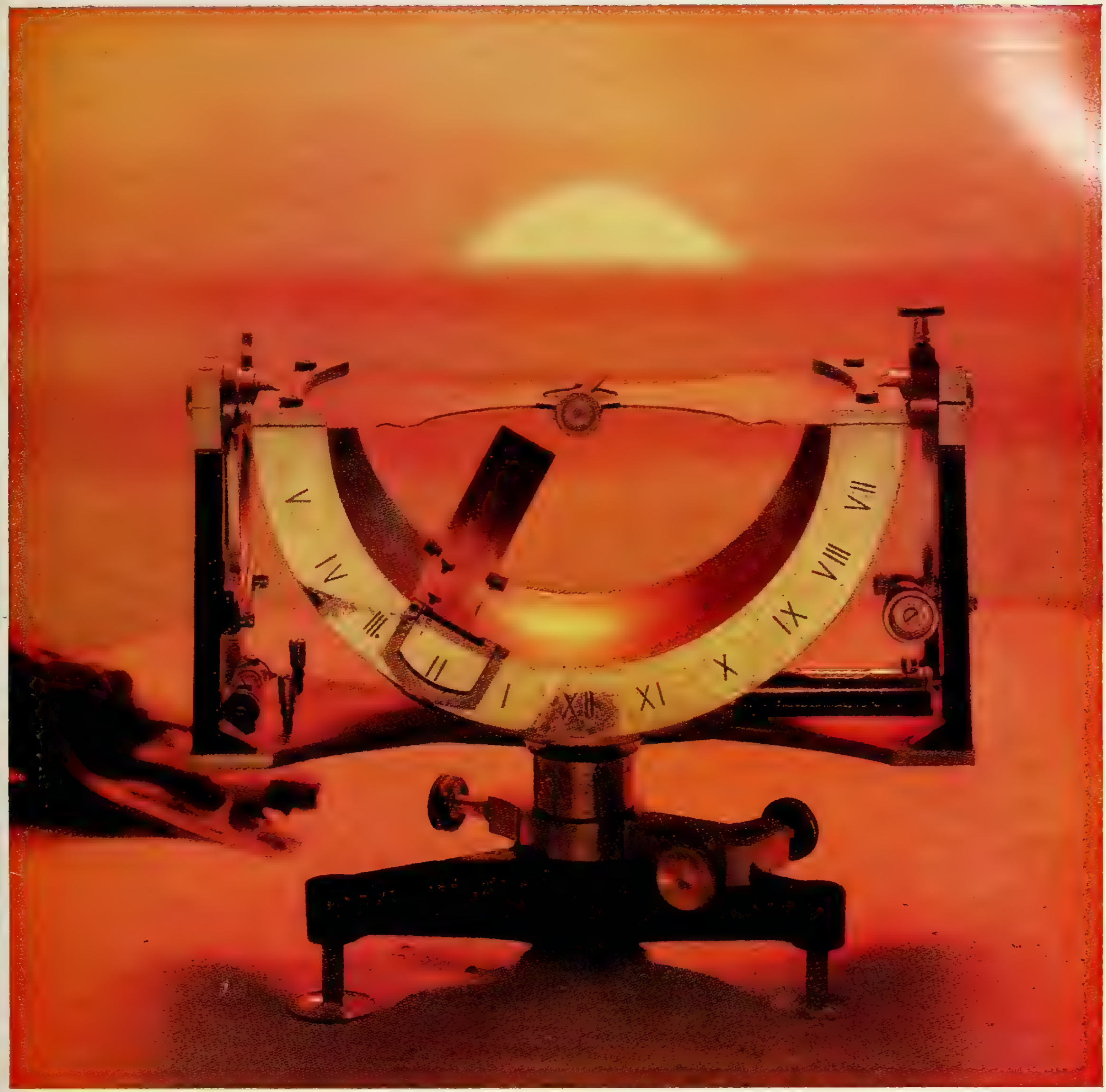
The effect on the probability of program success is also clear.

"When you begin to lower your effort," Storm points out, "it's not the least capable man who leaves first, it's the most capable. You lose critical talent and you may actually need the same or more manpower to reach the same goal at a later date."

Whether we continue, as we should, to regard the effort to reach the Moon as a race—a peaceful competition with the Soviet Union—or whether it is now to be regarded by a hypercautious Administration as a project of lower national urgency, one thing must be kept clearly in mind in regard to the budgets of the National Aeronautics and Space Administration.

To stretch out *Apollo* funding now will cost money, not save money, and it will reduce, not increase, the chances of successfully placing an American expedition on the Moon and returning safely.

William J. Coughlin



Wheeler's Solar Chronometer (American—19th Century)—Courtesy Cranbrook Institute of Science

from solar chronometer to space booster guidance

The Wheeler Solar Chronometer was designed to indicate true sun time and longitude, with corrections for the seasons and the earth's position. Highly accurate though it was, the instrument had the basic fault of all sun dials: it was utterly worthless when the sun went down.

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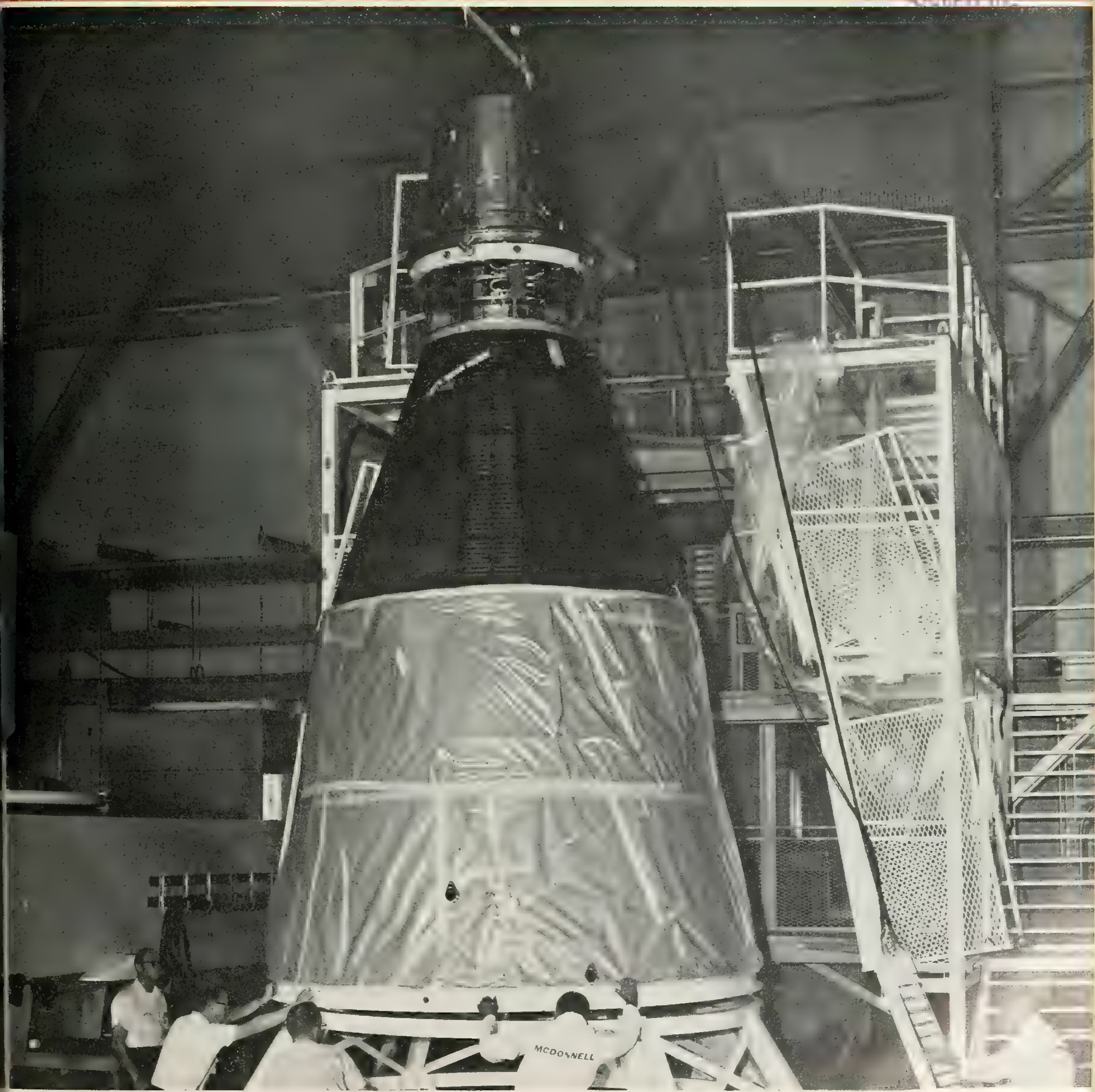

First Gemini Arrives at Canaveral

NASA Reorganizes to Speed Decisions .

Doppler Study Promising for Navigation

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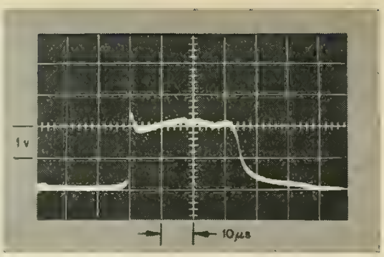
THE QUIET MEN AND THE MINIATURE REACTOR One of man's strongest motivating forces is his need to know. It is part of the sense of wonder in a child's eyes—an inborn desire for the answers that will add up to maturity. It is also a source of inspiration for the research scientists of America's aerospace industry.

Today—quietly—certain of these specialists are advancing down the byways of nuclear research, through the unknown realm of the universe, and into the very cosmos where facts and philosophy blend. Along the way, they find more new questions than answers. But already their answers are bearing fruit—for example, miniature new SNAP reactors from NAA's Atomics International Division, with myriad uses on earth, in space, and on the moon.

Research scientists like these are the explorers of the new Age of Space. Seekers for the headwaters of knowledge. Trail breakers whose unerring sense of direction can lead mankind to new plateaus of well-being.

These are the quiet men.

North American Aviation is at work in the fields of the future through these divisions: Science Center, Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.



Super-orbital entry of a space vehicle—one returning to earth from a planet, rather than from an earth-orbiting mission—would result in searing *radiative* heating in addition to the more familiar *convective* type. As a spacecraft nose enters atmosphere, it pushes the thin air aside. A boundary layer is formed next to the skin. Ahead of that is a compressed mass of air; fronting that, a shock wave. The air behind the shock wave becomes incandescent, ionizes, and radiates to the heat shield. Within the boundary layer, friction heats the nose cone by convection.

Lockheed scientists believe that at higher than escape speed a blunt-nosed vehicle may be unable to sustain the radiative heating. Consequently, a return to the previously discarded sharp nose is indicated. Fluid mechanicists are calculating the heat load, determining how rapidly the nose will ablate and how to keep it sharp. Current shock tube tests are providing some clues.

Another research project in Lockheed's Fluid Mechanics Laboratories relates to the flow of buoyant fluids. A typical study program is the determination of how liquid hydrogen, stored in a tank in space, stratifies. This, in turn, determines the level of pressurization required in order to extract all of the fluid. Scientists made a mathematical model of what they think occurs inside the tank. With this as a guide, an actual tank was constructed to obtain measurements and photographs of the flow to verify their theories.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 16

October 14, 1963

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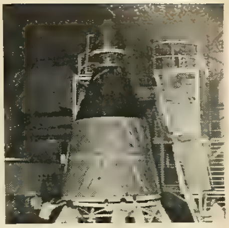

The first Gemini spacecraft to reach Cape Canaveral is moved into position in Hangar AF before post-arrival checkout of the McDonnell-manufactured vehicle is made. The two-man capsule arrived at the Cape Oct. 4. See page 16.

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Over-40 Placement

To the Editor:

We in Forty Plus of New York read with much interest the letter in your Sept. 9 issue from the wife of a 50-year-old Winston-Salem, N.C., executive who was laid off when his employers went out of the defense business. You rendered a public service by publishing this reminder of a serious plague on our national economy.

Our country can ill afford the loss of able, experienced executives who are being relegated to the "limbo" your correspondent so aptly describes. Ignoring the values of high-level experience is as economically shocking as deriding the profit potentials of educating youth.

Forty Plus of New York was organized nearly 25 years ago to combat this shortsighted employment policy, and we are placing talented executives in jobs at the rate of about one man per working day. We do this by working together cooperatively, on the theory that 100 to 125 men can do far more in the way of job hunting than any individual can do by himself. We do all the work ourselves—no one in the club receives a salary or expense account, nor do we have any salaried employees—and we scour the executive employment field for the benefit of our members.

Our membership is limited to unemployed male executives over 40 who live in the Metropolitan Area of New York City, but there are other Forty Plus Clubs in Norfolk, Washington, D.C., Philadelphia, Boston, Chicago, Denver and Los Angeles. Perhaps your correspondent's husband would find it helpful to contact the club nearest to his base of operations.

Col. James E. Wilson
President
Forty Plus Club of New York, Inc.
New York, N.Y.

Newton Revisited

To the Editor:

While conducting a quantitative analysis of my invention of a radically new prime mover, I noticed the measurements were not coinciding with our present description of angular momentum.

I wrote to the National Academy of Sciences and they confirmed my suspicions. *Angular momentum,* as defined in most physics books, as *moment-of-inertia* × *angular velocity,* is erroneous. The correct definition of angular momentum is *mass* × *radius* × *angular velocity.*

John W. Ecklin
San Diego, Calif.

An excerpt from the letter sent to Mr. Ecklin by the National Academy of Sciences—National Research Council, and signed by an executive officer:

"Your computation utilizes an erroneous definition of angular momentum. The *angular momentum* of a particle moving at constant speed in a circle is the *mass* of the particle × its *angular velocity* × the *radius.* The principle of conservation of angular momentum applies to the angular momentum so defined. It means, therefore, that if the radius is halved without change in the mass, the angular velocity will be doubled, not quadrupled."

Textbook revision needed?—Ed.

CE's Space Construction

To the Editor:

The article entitled "Mississippi Facility's First Firing Set for Summer of '65" (M/R, Sept. 30, p. 37) is an excellent presentation of the huge test complex the U.S. Army Corps of Engineers is constructing at the Mississippi Test Operations of the Marshall Space Flight Center. Conspicuous for its absence, however, is any reference to the U.S. Army Corps of Engineers, selected by NASA for real estate, engineering, design, and construction responsibilities at the test site.

I am confident that this omission was inadvertent; possibly you would want this called to your attention so that you can give the Corps credit in future articles.

David Roberts
Colonel, Corps of Engineers
Deputy District Engineer
for NASA Support
U.S. Army Engineer District
Mobile, Ala.

Failure to mention the Engineers certainly was inadvertent. Perhaps we sometimes tend to take it for granted that readers are well aware of the indispensable part performed by the Corps in the space program.—Ed.

Lunar Probe Failures

To the Editor:

The writer hastens to make a correction to Mr. H. Alfred Roloff's letter (M/R, Sept. 30, p. 12) regarding the number of lunar probes attempted by the U.S.

His list is essentially correct. However, the Sept. 24, 1959, event was *not* an attempt to orbit another Moon probe; it was a *static test* of the *Atlas-Able IV* rocket combination for the *next* try.

The *Atlas* booster exploded on the pad. The 375-lb. instrument payload was *not* on the missile. It was used in the Nov. 26, 1959, attempt which, unfortunately, was also a failure.

The most successful lunar probe to date was *Ranger III.* It came within 22,862 miles of the Moon. Excessive acceleration in the first-stage *Atlas* caused the payload to pass the Moon and go into solar orbit.

Horace D. Westbrooks
Griffin, Ga.

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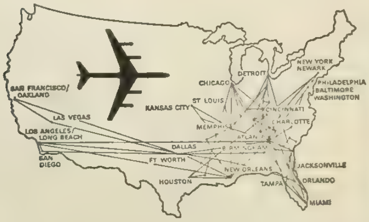

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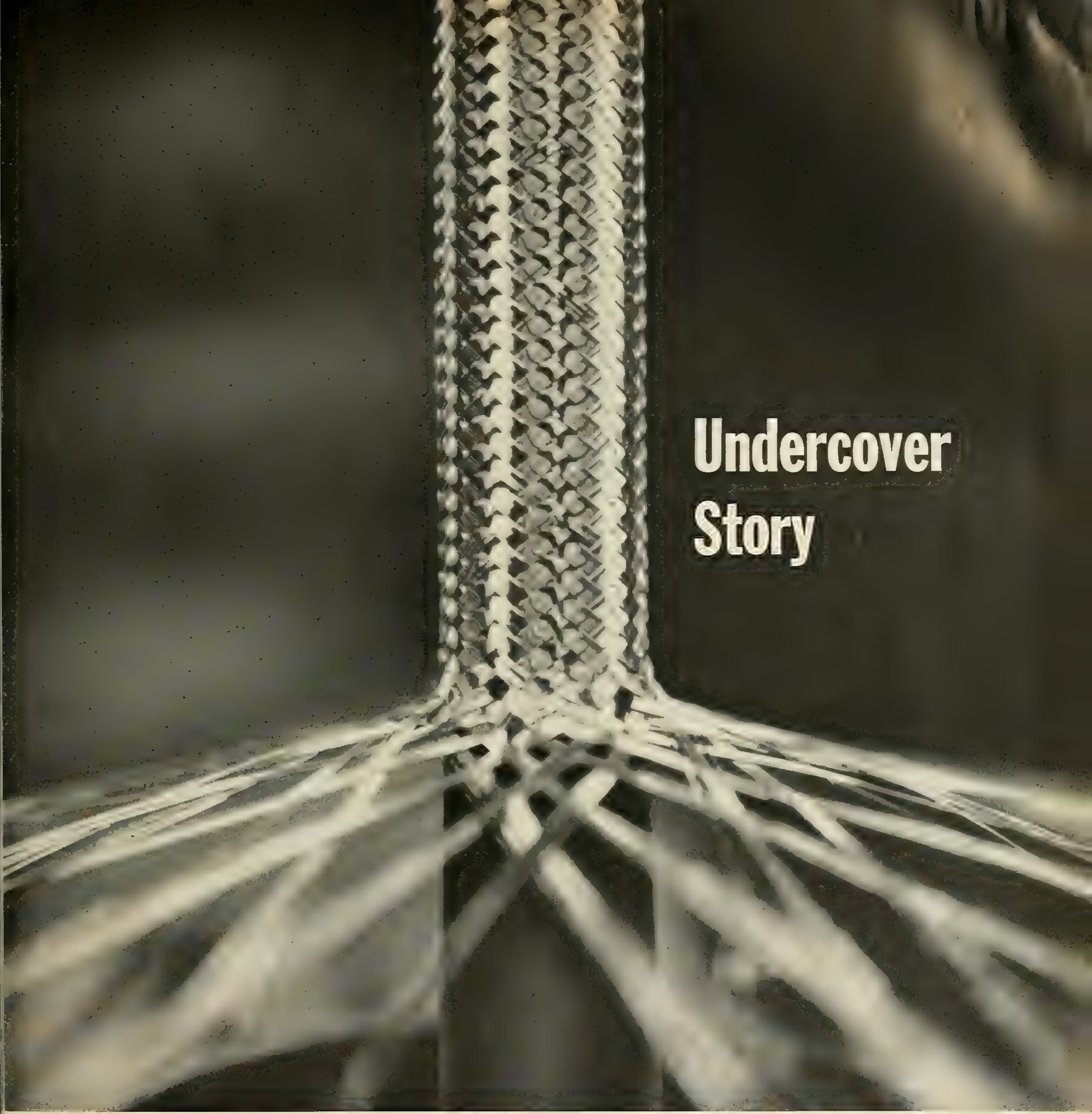

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The Countdown

WASHINGTON

$2-Billion Polaris Surface Fleet Planned

Chances are good that an agreement may be signed at the May, 1964, NATO meeting calling for a surface fleet nuclear missile force which will cost more than $2 billion. Some 25 ships would be provided under the program, each equipped with eight *Polaris* missiles. Development of the weapon system will take 26 months, while fully operational system will require about 50 months. Thus far, Italy, Turkey, West Germany, the Netherlands, Greece and the U.S. have agreed to the program. Belgian agreement is expected soon. United Kingdom indicated renewed interest in the program by sending representatives to meetings recently held in Paris. About half of the total cost of the project would be paid by the U.S.

Vela Launch Due This Week from Cape

Initial launch of the first two Air Force *Vela High Altitude* satellites is set for Oct. 14 from launch complex 12 at Cape Canaveral. Tandem shot will employ an *Atlas-Agena* booster to place the two 485-lb. spacecraft into circular 50,000-mi. orbits. Designed for detection of nuclear explosions, the first two satellites will carry 10 X-ray detectors, six gamma-ray detectors and a dual neutron counter. Program, designated 823, calls for four more launchings during 1964 of two satellites each.

Two Major NASA Shots Due by Year's End

NASA has two major space shots scheduled for launch from Cape Canaveral in December—*Ranger VI* and *Saturn V*. Slippage of both into early 1964 is considered possible. *Ranger* is particularly vulnerable, since it must use the same pad as the Air Force 823 program and will be affected by any slippage in the *Vela High Altitude* shot.

NASA Disappointed by Laser Response

NASA scientists concerned with development of optical space communications systems are disappointed by the small number of U.S. firms intending to participate in the upcoming laser tracking experiment using the *S-66* satellite (M/R, Aug. 5, p. 21). Planned participation by European organizations is said to far exceed U.S. commitments. Launching of the satellite, which has slipped, is still expected within the next two or three months. It is regarded by NASA as the first big test of feasibility of optical space communications.

Moondust Sampling Program Is Proposed

NASA headquarters has given tentative approval to Project Luster as a projected method of sampling the Moon's surface without going there. Planned by the Space Sciences Div. of Ames Research Center, the program proposes to catch lunar dust knocked off the Moon by meteorite showers. Above a certain impact velocity, it is believed, a meteorite should throw out more than its own weight of dust. Some, it is theorized, would go into Earth orbit. An attempt to collect this with an *Aerobee 150* sounding rocket is planned. Main contractor for the rocket-borne experimental equipment is Electro-Optical Systems, Inc. First flight date: late 1964.

Collier Trophy Goes To Seven Astronauts

The annual Collier Trophy was awarded to the seven astronauts of Project *Mercury* by President Kennedy in ceremonies at the White House last week. It was also disclosed that the Collier Trophy committee has recommended to the sponsors, *Look* magazine and the National Aeronautics Assn., that they consider the possibility of awarding two trophies each year—one for aeronautics and one for astronautics.

INDUSTRY

M-2 Lifting Body Spreads Its Wings

Wings are being fitted to the full-size model of the *M-2* lifting body vehicle currently in the 40-by-80-ft. wind tunnel at NASA's Ames Research Center. Doubling as protective covers for the landing gear, the wings meet along the centerline of the underside of the vehicle when folded. When the landing gear is lowered, the wings swing outward on hinges. Conforming to the underbody contour, they are sharply curved along the short span with an almost straight chord.

Five Firms Bid on Lunar Orbiter Spacecraft

Five firms submitted bids on the incentive contract for the *Lunar Orbiter* spacecraft. They are Martin-Baltimore, Hughes Aircraft, Space Technology Laboratories, Lockheed Missiles and Space Co., and Boeing. Contract award is expected within one or two months.

Spaceborne Laser Communications Funded

Development of a spaceborne laser communications system which probably will see experimental use in Project *Gemini* got a major boost last week with disclosure of a $83,515 Manned Spacecraft Center award to IBM's Federal Systems Div. for development of a prototype one-way optical link suitable for manned Earth-orbiting vehicles (M/R, Aug. 26, p. 9). Contract will run through September, 1964. System is likely to be designed around a gallium arsenide-type injection laser. Ground station for the experiment will be located at White Sands, N.M. IBM demonstrated GaAs laser modulation capabilities this summer (M/R, May 27, p. 48).

INTERNATIONAL

NASA To Launch French Probe at Wallops

First phase of U.S. space cooperation with France is scheduled to begin this week with the NASA launch from Wallops Island on Tuesday of a payload built by the French National Center for Telecommunications (CNET). Booster is an *Aerobee 150A*. The probe will be directed at the region between 46 and 62 miles altitude for measurements of electric and magnetic VLF field strength and local electron density. Program calls for later launch of a French-built satellite by a *Scout* booster to study VLF characteristics above 62 miles.

The Missile/Space Week

JKF to Review Space Goals

President Kennedy has told Congress that a major review of the space program is being undertaken, and that he will have a new Administration statement on the program in time for NASA's Fiscal '65 authorization hearings.

An Administration space official, however, declared immediately that he expects no changes in the lunar landing program or significant cutbacks in funding as a result of the review.

The President's statement was made in a letter that he said was an interim reply to a letter from Rep. Olin Teague (D-Tex.). The Congressman, chairman of the House Manned Space Flight subcommittee, asked the President if the Administration was dropping the national goal of landing a man on the Moon by 1970.

In discussing the President's reply, Dr. Edward G. Welsh, executive secretary of the National Aeronautics and Space Council, said that the "review mentioned that it is not a special report."

"There is a very extensive review every year during the preparation of the budget," Welsh said. "I think that is what the President is referring to."

He indicated that one result of the review will probably be a decision as to which agency—NASA or DOD—will manage a manned orbiting space station program.

Welsh added that he doesn't expect any changes in the lunar program as a result of it.

In his letter to the President, Rep. Teague said "In view of your statement to the United Nations suggesting the possibility of a joint venture with the Russians to reach the Moon, I am very anxious to know whether or not this national goal is being abandoned or changed."

"I was disappointed in the suggestion. I have been a very strong supporter of the space program, believing we can be the first nation to put a man on the Moon and knowing that we must achieve this goal if we are to help establish the fact that space will be used for peaceful purposes. Also I believe that our national security and the security of the rest of the Free World is very dependent upon the success of our space program."

Titan III Hardware Progresses

The first major segment of the *Titan III* space launch vehicle—a tank dome—has been completed at Martin Co.'s Denver Div.

The aluminum hemisphere is the prototype for the aft dome of the oxidizer tank in the second stage of the *Titan III* core vehicle. Tests are scheduled soon to confirm its capability to withstand the repeated pressures resulting from frequent loading and unloading of propellants on the launch stand, hydrostatic test pressures, flight load with maximum pressure and ultimate design pressures.

A second dome also is slated for additional tests, with the third scheduled as a flight article for the "A" configuration of the *Titan III* booster.

GE Gets Nose Cone Award

General Electric's Missile & Space Div., Philadelphia, has been selected to produce the *Minuteman II's* Mark XII re-entry vehicle.

Mark XII is designed to take advantage of the improved *Minuteman's* flexibility, increased range and accuracy.

Announcement was made by Sen. Joseph S. Clark (D-Pa.), who said value of the contract could run into the $50 millions.

The award will help stabilize employment at GE's Philadelphia plant, where more than 1,000 workers have been laid off since January.

Shots of the Week

Two attempted *Atlas* shots from Vandenberg AFB, Calif., this week exploded shortly after takeoff.

An *Atlas-F* blew up Oct. 3; and an *Atlas-D*, on the 8th.

Air Force investigators are attempting to determine cause of the mishaps.

- The Navy successfully launched a *Polaris A3* from the carrier, U.S.S. Observation Island, Oct. 4. Launch used new steam technique (M/R, Oct. 7, p. 17).

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Explorer XIV Signals Cease

Explorer XIV's transmitter has stopped after 10 months in orbit.

Officials at the NASA Goddard Space Flight Center say there is only a remote chance the satellite will resume normal operation.

First indications that data transmission problems had developed came in August when the satellite's transmitter failed to modulate properly.

Although intermittent signal modulation has occurred since August, almost no usable data have been received. Cause of the problem has not been pinpointed.

The 89-lb., solar-cell-powered satellite was launched by a *Delta* vehicle on October 2, 1962.

During 10 months of operation, it radioed some 6,500 hours of data on six scientific experiments aboard. Although all the data have not been analyzed, the space agency said a number of new insights have been provided into various space phenomena, such as:

- Mapping of energetic particles shows that the Earth's magnetosphere flares away from the Earth to take shape similar to a somewhat pointed oval.
- General confirmation that the vector magnetic field merges gently from its dipole configuration to a radial field with increasing distance on the night side of the Earth near the equatorial plane.

Centaur Test-Fired

The *Centaur* space vehicle with its new RL-10 engines underwent flight-duration static test-firing Oct. 8.

General Dynamics/Astronautics engineers conducted the test, first with the improved dual hydrogen-oxygen engines. The engines delivered the 30,000-lb. total thrust anticipated.

The test vehicle was sister craft of the *Centaur* being readied for flight test at Cape Canaveral.

Gemini Arrives at Cape

The first *Gemini* spacecraft has been delivered to Cape Canaveral.

The spacecraft will be instrumented at the Cape to transmit data on structural integrity, pressure, vibration and temperature during flight. After the equipment is installed it will be mated to the *Titan II* booster, due at Canaveral soon.

The *Gemini* capsule is scheduled to be placed in orbit, but no attempt will be made to recover the spacecraft.

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To speed decisions . . .

NASA Reshuffles Headquarters

by Hal Taylor

A MAJOR REORGANIZATION of NASA headquarters designed to increase control over its field installations will become effective Nov. 1.

Other changes in its manned lunar landing program organization will follow, Deputy Administrator Dr. Hugh L. Dryden told MISSILES AND ROCKETS.

The principal change in the headquarters setup calls for the field centers to report directly to one of three associate administrators on all matters concerning the installation.

Previously, the centers reported on space project matters to one or more headquarters program directors. On matters concerning the general operation of the centers, including budget and personnel, the centers reported to Associate Administrator Dr. Robert C. Seamans.

The other major organizational change combines space sciences and applications programs under one associate administrator, Dr. Homer E. Newell.

• **Streamlining**—NASA said the new organization will speed decision-making because it will integrate both management and technical activities at a point just short of Dr. Seamans' office.

It will also relieve Seamans of responsibility for direct management of the field centers, enabling him to devote more time to "broad agency policy matters."

More changes are expected to come in the wake of the major reorganization. One area cited by Dr. Dryden was the Manned Spaceflight project office. He said an effort will be made to provide quicker communications between headquarters project directors and the field centers concerned with the program.

This is expected to involve the establishment of an *Apollo* project director at NASA headquarters who will report to Dr. George Mueller. It probably will also mean that the current positions of deputy directors to Mueller for various portions of manned space flight will be dropped.

Apollo project directors may also be established at Marshall Space Flight Center, Launch Operations Center and Manned Spacecraft Center.

One change in the manned spaceflight program has already been made. Dr. Joseph Shea has been appointed program manager, *Apollo* spacecraft, at the Manned Spacecraft Center. He formerly served as Deputy Director (Systems) in the Office of Manned Spaceflight.

• **Reorganization details**—Associate Administrator Robert C. Seamans will continue to serve as the agency's general manager. Reporting directly to him will be the three associate administrators, who will have direct management responsibility for the centers involved in their programs.

Mueller will be Associate Administrator for Manned Space Flight. In addition to heading Projects *Gemini* and *Apollo*, he will direct the management affairs of Marshall Space Flight Center, Manned Spacecraft Center and Launch Operations Center. He is now deputy associate administrator for manned space flight centers and director of the Office of Manned Space Flight.

Dr. Raymond Bisplinghoff, director of the Office of Advanced Research and Technology, becomes associate administrator for advanced research and technology. He also will direct the efforts of four NASA research centers—Ames Research Center, Flight Research Center, Langley Research Center and Lewis Research Center.

Newell, presently director of the Office of Space Sciences, becomes associate administrator for space sciences and applications. He will be responsible for scientific explorations of space and for communications, weather and related peaceful applications. He also will direct management of Goddard Space Flight Center, Wallops Stations, and Pacific Launch Operations Office, and will administer NASA's contract with the California Institute of Technology for operation of the Jet Propulsion Laboratory. Under the new oragnization, Robert Garbarini, director of the Office of Applications, becomes director of applications and reports to Newell.

Seamans will have a staff of five persons, headed by Walter L. Lingle as deputy.

Earl D. Hilburn, now deputy associate administrator for other than manned space flight centers, assumes Lingle's present responsibilities as deputy associate administrator for industry affairs. He will also be responsible for directing quality assurance and reliability activities.

John Young, director of the Office of Administration, retains that function as deputy associate administrator for administration.

D. D. Wyatt, director of the Office of Plans and Program Evaluation, continues a similar function as deputy associate administrator for planning.

Adm. Walter Fredrick Boone (USN Ret.) continues as deputy associate administrator for defense affairs.

The Office of Tracking and Data Acquisition, headed by Edmond C. Buckley, will continue to report directly to Seamans.

Several officials reporting directly to Administrator James E. Webb and responsible for agency-wide support functions will become assistant administrators.

Julian Scheer will become assistant administrator for public affairs, responsible directly to the administrator.

In addition to his present responsibilities as assistant administrator for technology utlization and policy planning, Dr. George Simpson will become Associate Deputy Administrator of the agency. In this capacity, he will coordinate work of staff members reporting directly to Webb and deputy administrator Dryden.

Richard Callaghan, a special assistant to the administrator, will become assistant administrator for legislative affairs. Paul G. Dembling, director of that office, will become executive director of the newly created Policy Planning Board, which will review, re-formulate and evaluate policies embracing the full scope of NASA activities.

Arnold Frutkin, director of the Office of International Programs, retains that responsibility as assistant administrator for international programs.

The title and function of John A. Johnson as the agency's general counsel is unchanged. ■

According to Webb . . .

$5.1-Billion NASA Bill Would Delay Lunar Program 2-3 Years

by Heather M. David

NASA's FY 1964 budget is fast settling at a level which Administrator James E. Webb earlier said would delay the lunar program "from two to three years" and increase the cost "by about $3 billion."

The House is expected to pass the $5.1-billion appropriations bill as reported by the Appropriations Committee without much change, since major reductions on the floor would be expected to show up in the authorization bill. The appropriations bill is $251 million below the legislative authorization passed by both Houses.

While the Senate may add from $100 to $150 million to the appropriations bill, joint action will bring it down again to $5.2 billion or below. It was this amount—the same figure approved by the House Science and Astronautics Committee in the authorization bill—that Webb referred to in testimony before the House Appropriations Independent Offices Subcommittee.

Webb issued a statement last week saying that the funding level must be raised to the $5.35-billion authorization level "or the schedules of work under NASA's contracts with aerospace industry must be cut back." Webb added that the agency would be able to complete the 2,000 hours of space flying now scheduled prior to the lunar landing, and do the lunar exploration before the end of the decade, only if the bill is increased (presumably by the Senate and subsequently in conference) or by a supplemental bill and increased FY 1965 funding.

• **Supplemental**—There are indications that NASA will ask for supplemental funds this year if the Senate does not make a substantial increase in funds. Deputy Administrator Dr. Hugh L. Dryden said such a plea is possible this year, because the situation differs from that in FY 1963, when Administrator Webb decided against a supplemental request. This year the appropriations may be so much lower than the authorization that the agency could recover a substantial amount (up to $5.35 billion authorized) without going through the House Space Committee again. The Appropriations Committee is empowered to release all funds authorized, at any time during the year.

Webb indicated to the Appropriations subcommittee that he probably will ask the Bureau of the Budget again next year for $6 billion, but acknowledged he would be given less than that. He also noted that NASA has projected a steady buildup of $5.5 to $6 billion for about two years, then a dropoff in budget requests. He said that if Congress cut the budget to $5.2 billion this year, he would expect it to level off and run at the same rate until the lunar program was completed, which would result in the delay.

• **Programs**—Although the agency will not draw up new operating plans until the final appropriations figure is passed, some programs were mentioned in testimony before the House Independent Offices Subcommittee.

The advanced synchronous communication satellite will be stretched out to absorb a $7-million reduction, by removing $6.5 million from launch and spacecraft operations, NASA officials said.

• **No duplication**—Some letters entered in the record of the hearings cleared up the question of duplication of facilities between DOD and NASA —a much-referred-to topic during the hearings. A jointly signed statement by Dr. Harold Brown, director of Defense Research and Engineering, and Dr. Robert C. Seamans, Jr., NASA associate administrator, said that of 217 items reviewed, 62 warranted more detailed study. However, after study it was agreed that "no unwarranted duplication existed in the fiscal year 1964 facility plans of NASA and DOD."

The Department of Defense also was asked in a letter by Sen. Clinton P. Anderson (D-N.M.) to comment on the usefulness to DOD of NASA's proposed Boston Electronics Center. Dr. Brown answered that "we would expect that much of the research carried forward by NASA in the proposed facility would serve a useful purpose for the Department of Defense." ■

DOD Appropriation Is Compromise $47.2 Billion

CONGRESS GAVE final approval last week to a compromise $47.2-billion appropriations bill for the Dept. of Defense during Fiscal Year 1964.

The measure provides almost $120 million less than the Senate had voted earlier, and $138 million more than the House bill carried. Total appropriation is $1.794 billion below DOD's FY '64 budget request.

Prior to the final votes, Senate-House conferees accepted the Senate action on communication satellites—an increase of $23 million over the House bill, bringing the total for that program to almost $99 million.

Funds for the *Mobile Medium Range Ballistic Missile (MMRBM)* now total $73 million for FY '64 work. Previously, the House had agreed to only $43 million, while the Senate had approved $103 million.

A $5-million cut made by the House in the Army's *Lance* missile program and restored by the Senate was okayed by the conferees. This amount was to be offset by a corresponding reduction in the aircraft development program, the conferees reported. A $7.2-million fund in a classified project, which had been deleted in a general House reduction of money for research, development, test and evaluation (RDT&S), was restored by the Senate and approved in the conference.

Total Air Force RDT&E in the compromise bill is $3.453 billion. Army RDT&E funds amount to $1.386 billion, and Navy $1.526. AF missile procurement was brought to the Senate level of $2.142 billion. Navy aircraft and missile procurement now totals $2.889 billion, and Army equipment and missiles $2.931 billion.

Explaining report . . .

NASA Lauds Industry Performance In Project Mercury Production Tasks

Officials note that only a small number of components were involved in criticisms; summary called guide to improvement in future programs

NASA STAUNCHLY DEFENDED industry workmanship on the *Mercury* program in testimony before the House Science and Astronautics Committee last week.

Mercury flight operations chief Walter Williams, director of spacecraft and flight missions George M. Low, and chief of manned spaceflight Dr. George Mueller appeared with other NASA officials to explain statements appearing in one section of the 444-page report issued at the recent Project *Mercury* summary conference in Houston which appeared to criticize industry for poor-quality workmanship and material.

The officials said the statistics carried in the report involved only a small number of components and, considering the complex nature of the project and the stringent specifications laid down,

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Experts Back Cooper Sighting Claims

NASA HAS MARSHALLED a number of visual experts and come to the conclusion that Astronaut Maj. L. Gordon Cooper *did* see roads, chimneys and vehicles from his orbiting *MA-9* capsule.

Dr. Robert Voas, psychologist and human factors chief for the Manned Spacecraft Center, said: "We can't be entirely sure because we don't know what actually was there when he looked, but it is highly probable he was right."

Voas disclosed to MISSILES AND ROCKETS that the Space agency had consulted the Scripps Institute of Oceanography of the University of California, visual specialists, to try and determine whether Cooper could have seen the objects he reported. This laboratory gathered data on the size of the objects—one an 8-ft.-wide dirt road on the U.S.-Mexican border and a vehicle Cooper believed he saw on it—and the relative brightness and contrast of these objects. The laboratory reported that it was very possible Cooper was correct.

Various scientists and jet pilots accustomed to high-altitude flying had expressed both doubt and belief in Cooper's observations. One well-known doctor was quoted as having said that Cooper "had hallucinations," but other observers later said he may have been misquoted.

NASA scientist Dr. John A. O'Keefe, assistant chief of the Theoretical Division at Goddard Space Flight Center, also dismissed the theory that a magnification effect might be caused by the difference in refractive index between the atmosphere and the vacuum of space. O'Keefe and co-authors Dr. Lawrence Dunkelman and Dr. Paul D. Lowman of NASA and Dr. Stanley Soules of the Weather Bureau and William Juch of the University of Minnesota, said this difference is relatively small, and maximum result could only be a magnification of 1.00002, or a rise of 8.5 ft.

The researchers also pointed out that while human visual acuity usually is taken at one minute of arc, under combinations of illumination and contrast objects approximately ½′ of arc or even smaller can be seen. One expert quoted gives the minimum visible white square on a black background as being 10″ of arc. This, O'Keefe points out, corresponds to 30 ft. at 100 n. mi.

Line or ribbon objects are much more easily distinguished, and may only be one-sixth or less the diameter of a circular object to be seen.

- **No weightless effect**—O'Keefe said also there was no reason to believe that weightlessness created improved visual acuity. All the astronauts have normal or better vision already, with Cooper's the best at 20/12.

Atmospheric conditions can work conversely to obliterate vision, O'Keefe said. While Cooper flew right over Los Angeles and San Diego, at an unclouded moment, he was unable to see the cities. This effect—caused by smoke, dust or haze, makes ground observations somewhat unreliable, he said.

were not at all surprising.

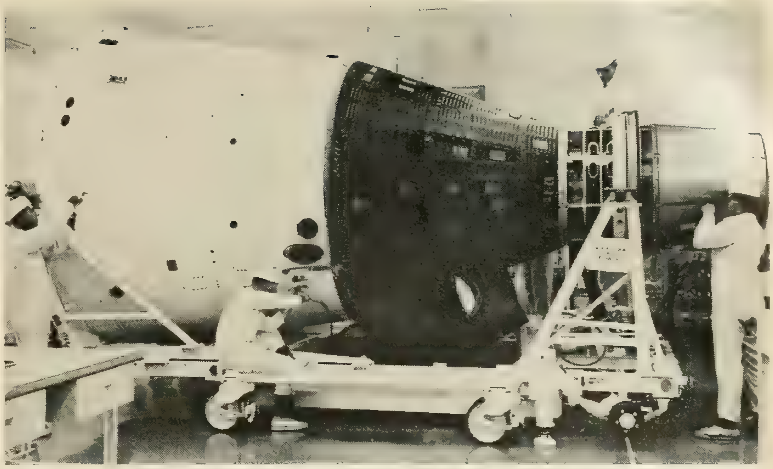
They reiterated that the summary for the most part praised industry's performance and was not intended to be critical. "We were candid in reporting some of the lessons we and our contractors learned about the problems and their solutions which permit us to make better space hardware," Mueller said. "It was a summary of those things it is important to avoid in future space programs."

• **Explanations**—In a point-by-point explanation of some of the statements in the book the officials told Congress:

—The purpose of the report was to point up good and bad, but NASA wants industry and government to know how to do even better.

—While the report stated that some *Mercury* flights might have failed if the astronaut had not been able to make adjustment, this is intrinsic in the system and stems from aircraft experience that man is a good backup.

—While some component failures caused delays in the schedule, NASA has put a great deal of emphasis on the design of *Gemini* and *Apollo* so that the systems are so arranged that they will be easier to work on. For instance, instead of being on top of one another they will be accessible so that one can be worked on without taking out others. Also, there will be additional test points so that systems can be tested without having to unplug them. In *Mercury*, if a component did fail, it took much longer to fix.



GEMINI SPACECRAFT NO. 1—first flight-rated vehicle—shown undergoing final inspection at McDonnell Aircraft in St. Louis before flight to Cape Oct. 4. Spacecraft is presently scheduled to be launched on an unmanned orbital flight early next year to test launch-vehicle and structural integrity.

—While the report stated that 50% of component spares were rejected during 1962 and 1963, the standards were very high, and these rejections did not have schedule impact, since they were discovered before installation. Also, the officials noted, these might have involved only one component in an entire system, in which case the system was rejected. Williams added that this percentage improved considerably during the program—as much as ½ or ⅓ of the initial rejection volume was eliminated. Some parts were rejected because of normal shelf-life attrition and for in-transit damage.

—The report states that there were 720 system or component discrepancies, of which 526 were due to quality of workmanship. Williams said this was true, but represented only a small number; there are about 100,000 parts in the *Mercury* spacecraft, disregarding units smaller than transistors or relays.

—The summary said 14/1,500 batteries were rejected for case leakage during preparation for *MA-8*. Low described this as "incipient leakage." Another official explained that these batteries did not have to be sealed under normal cabin conditions, but the specification was put in in case of cabin decompression.

—While in one case a subcontractor did use black iron when a part should have been stainless steel—causing some corrosion—the part number did not have the "S" which would have specified steel. Low said there is little difference in appearance, so that it was not detected until the corrosion began. This kind of thing has occurred before, Mueller added, and will undoubtedly occur again. There was not falsification of materials, however.

—The "dirty spacecraft picture" contained on p. 249 of the report had no scale, and actually amounted to a small amount of debris. The picture was included in the report as an illustration of how the problem of ultra-cleanliness needed for weightless operation was being solved.

• **Good relations**—The officials said relationships with industry have been excellent in the *Mercury* program, and pointed to their recent presentation of a Public Service Award to McDonnell's Cape Canaveral chief John Yardley. They added that a survey was taken of attendees of the conference, and many commented that not enough problem solutions were discussed.

In answer to Congressional questioning, the NASA officials said that the cost of rejected parts and adjustments is borne by the government under the present cost-plus-fixed-fee system. Mueller indicated that he will try to increase the incentive-fee-type contracts so that there will be a penalty for "not making good."

NASA said that it will also increase its quality assurance efforts on the *Gemini* and *Apollo* program, by increasing considerably the number of inspectors and quality-assurance personnel working in the plants and at the Cape.

Space photography also has given some important information. O'Keefe said the great coverage may lead to discovery of large geologic features which go unnoticed on conventional photographs, and pointed out some potential oil-bearing areas in Tibet photographed by *MA-9*. *Mercury* photography proved that space pictures are potentially valuable for geologic reconnaissance, topography mapping, forest mapping, icepack and iceberg monitoring, supplementary weather observations and mapping of near-surface ocean currents.

• **Future flights**—Dr. Voas said NASA may work with the Scripps laboratory during the *Gemini* program to set up specific experiments to test visual observations made from space. The astronauts would be asked to look for certain pre-selected objects; the Scripps group would guage their visibility with special equipment measuring brightness, reflection, contrast and other distinguishing features.

- **Trouble spots**—Williams in a paper presented at the Houston conference, named inadequate performance by the aerospace industry as the cause of scheduling delays and rising costs in the *Mercury* progam.

He said the problems which repeatedly cost time and money included design requirements, qualification practices, definition of standards and testing procedures.

"In most trouble areas," Williams said, "careful and continuing attention to detail and the quality assurance program were not as effective in the aerospace industry as necessary."

He said the orbital weight of the spacecraft increased at an average rate of about 5% per week during 1959 and 1960. The overall weight increase caused an extensive requalification of the landing system, because the original design did not have a sufficient growth margin. He also charged that mismated connections, inadequate shelf-life periods, and incompatibility of materials caused many problems.

"Mismated or misconnected components continued throughout the program to ruin components and give false indications of trouble," he continued.

As far as on-the-shelf lifetimes were concerned, he said that occasionally these periods were not adequate, and some equipment had to be replaced because the lifetime limit had been exceeded while it was still in storage.

He also added that time and money were expended in *Mercury* to rectify cases where improper materials were found in the systems because someone had failed to follow the approved materials list.

- **Bill of particulars**—Further criticism of industry was contained in a paper on quality assurance. It charged that:

—In the *MA-9* mission, the three retro-package umbilicals and one of the two spacecraft-to-adapter umbilicals failed to separate from the spacecraft. Each of these contained two squibs, and initiation of either squib should have resulted in explosive disconnection. Post-flight analysis revealed that the umbilicals failed to separate from the spacecraft because the squibs were not loaded with the appropriate charge.

—In the *MA-9* backup spacecraft, a total of 720 system or component discrepanciees were recorded, of which 526 were directly attributed to a lack of satisfactory quality of workmanship. Of this number, 444 required specially scheduled time to correct.

Additionally, flight-safety considerations required that inspection be made of all parts and components scheduled for the space-flight program. These inspection requirements extended from the parts vendor to the Cape in order to locate and reject every defective or marginal part.

—As a result of inspection, 14 1,500 watt/hour storage batteries were rejected for case leakage during preparation for the *MA-8* mission. Several incidents of leakage were due to tooling holes not being plugged during manufacture. Others were from case cracks or undetermined sources. Also, an inspection of battery vent-pressure relief valves revealed dimensional deviations in valves after assembly, and improperly applied potting adhesive. Three of these valves failed to operate at proper pressures. These defective batteries were rejected following inspection at the Cape.

—Five failures were experienced on gas-pressure regulator assemblies in the *MA-8* reaction control system (RCS). An investigation of the failed assemblies revealed that internal scratches, inadequate cleanliness and improper torquing of end caps were contributing causes of these failures.

Also in the RCS, an examination of failed gas-pressure vent valves revealed damaged O-rings. In one case, an O-ring was found to be scuffed, while in another case the O-ring had a metal fragment driven into the material.

The *MA-8* spacecraft was de-mated from its launch vehicle and returned to Hangar "S" to replace the manual selector valve in the RCS due to a leakage encountered during a pre-flight pressure check of the system. When the valve was removed, it was noted that it had been installed out of alignment, so that an excessive side-load was induced into the valve internal parts.

—During an inspection of the escape-tower wiring for the *MA-6* primary and backup spacecrafts, it was found that the electrical connectors had improperly soldered joints. Additionally, it was discovered that the conductor wire had been improperly inserted into the solder as a result of the use of an 18-gauge wire with a 20-gauge solder pot. ■

Correction

AN ARTICLE in the Sept. 30 M/R incorrectly identified Navy Rear Adm. Eli T. Reich as deputy chief for programs and management—a post actually held by Rear Adm. Ralph L. Shifley.

Adm. Reich is expected to be head of the Surface-to-Air Missiles Project Office, when it is established.

Titan II Still Only Gemini Booster

TITAN II's vertical vibration problem is still four times as great as NASA will accept, but space agency officials are not considering any substitute booster for the *Gemini* program.

Charles Mathews, director of the two-man space flight program at the Manned Spacecraft Center, said that he still expects the problem to be solved in time for the first manned flight which now appears to be slipping into early 1965.

Mathews told MISSILES AND ROCKETS the vibration varies from flight to flight, but generally averages about one g. "Our stated requirement is that it be lowered to ¼ g, he declared. He denied, however, that NASA is giving any consideration to a substitute booster, such as an uprated *Atlas*.

The current rate is completely satisfactory for the *Titan II's* use as a missile, but it must be reduced for a manned flight so that astronaut scanning and peripheral vision are not impaired, he continued.

"The Air Force is extremely cooperative. Basically, we know what the problem is, but we still do not understand it completely."

- **First arrival**—The first *Gemini* flight spacecraft was delivered to Cape Canaveral on Oct. 4 and underwent an acceptance inspection last week. The spacecraft is currently scheduled to be launched on an unmanned orbital flight to test launch-vehicle and spacecraft structural integrity early next year.

The first spacecraft which will actually carry *Gemini* on-board systems is now in the final stages of structural assembly at the McDonnell Aircraft Corp., prime contractors for the program. The spacecraft is now scheduled for a ballistic flight in the summer of 1964.

Mathews said that the first manned *Gemini* flight is still scheduled for the fall or winter of 1964. Based on previous experiences in the manned flight programs, it is almost certain that technical and weather delays will push the scheduled three-day flight into 1965.

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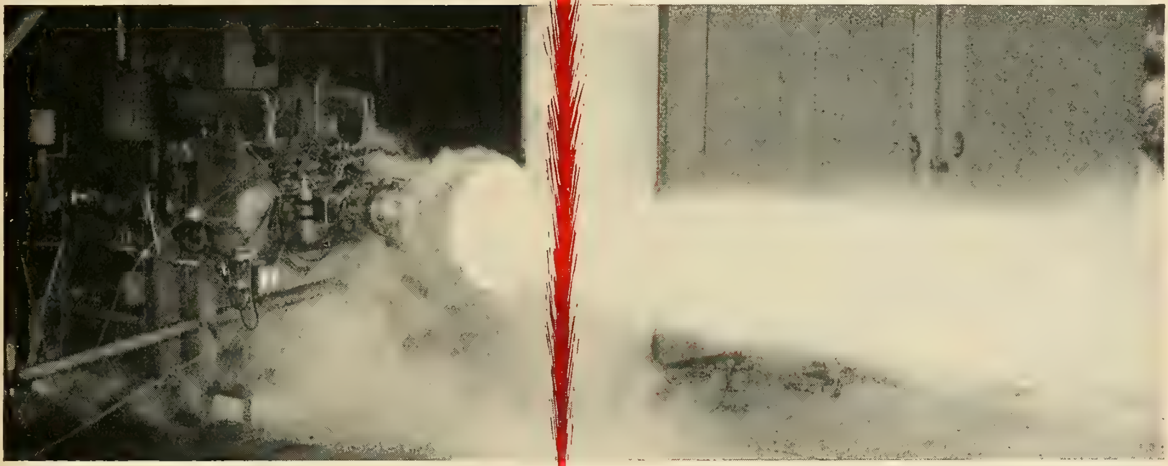

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At IAF Congress in Paris . . .

French Underline Growing IRBM/Space Integration

SNECMA paper proposes substituting nuclear stage in ELDO launcher; SEREB argues for options in booster guidance systems; U.S. delegates lead in presentations

THE RECENT International Astronautical Congress in Paris attracted more than 1,000 delegates from 34 Free World and Iron Curtain countries. This report on some of the principal papers presented was filed by a MISSILES AND ROCKETS *team composed of European Bureau Chief Frank G. McGuire, Paris Editor Jean-Marie Riche, and Contributing Editor Bernard Poirier.*

PARIS—The fourteen papers presented by French delegates at the recent 14th Congress of the International Astronautical Federation reflected the official De Gaulle policy of closely integrating IRBM and space endeavors. Even some of the French participants were unable to define any dividing point between missile and space exploration programs.

A paper on nuclearthermal propulsion by R. Alder and J. Lecompte of SNECMA, a firm involved in France's nuclear development program, discussed the possibility of substituting a nuclear-powered stage for one of Europe's satellite launchers. The European Launcher Development Organization (ELDO) obviously was the target of the proposal, since the *ELDO-C* rocket has an envelope which could accommodate the French-proposed 131.2-ft. combined chemical-nuclear-powered and clustered-motor vehicle.

An especially significant paper involving satellite booster guidance was presented by P. Polack of SEREB, France's IRBM agency. Dwelling heavily on pre-calculated matrices, as well as those involving unknowns of trajectory or launch site in military cases, the presentation was one of few released in Europe suggesting options in space program plans—options which may finally decide the level of continuing technical development in European industry.

The paper made several references to the capacities of well-known computer systems, and to calculations of external tracking methods for obtaining accurate positioning of vehicles during powered flight so that radio commands for thrust termination or stage separation may be transmitted.

Oliver Cahen and Eugene Dieulesaint of CFTH predicted that, given additional financial investment, France could develop a usable 1-3-kilowatt solar power supply for spacecraft in four or five years, and a 50-100-kilowatt nuclear powerplant for space use in 8 to 10 years.

- **Hardware and systems**—An advanced self-contained space guidance system was described by F. V. Johnson and J. D. Welch of General Electric-Schenectady, which is developing techniques and components for the system under U.S. government contracts.

Comprised of an advanced inertial subsystem and an electro-optical tracker, the method uses a multi-mode TV tube-type tracker, electrostatically supported free-rotor gyros, a "new type of electrostatic accelerometer," and an advanced guidance/navigation computer.

They said the system eliminates the need for multiple trackers, precision electromechanical drives, and readout devices. It is claimed to be capable of handling either Earth-Moon manned missions or long-distance interplanetary unmanned flights.

In the area of attitude control, several papers described extendable tubes for satellites, including plastic and metal versions also usable as antennas. E. H. Wrench, of General Dynamics/Astronautics, discussed "Vertistat," a gravity-gradient system for keeping a satellite pointed in the proper direction. He said it has applications in both communications and "observation satellites."

William B. Knowles, Jr., of Hughes Aircraft Co., reported results of a series of tests on lunar landings, using analog computer simulation. In evaluating a mode of manual-controlled descent for manned vehicles, derived from the *Surveyor* soft-landing guidance system, two operators—one handling guidance control and the other thrust control—made a total of 155 trial landings. The results showed 68% acceptable soft landings within one mile of the desired point; 22% crashes; 10% aborted or hovered too high.

During the first 20% of the trials, Knowles said, only 49% of the landings were satisfactory, but during the last 20% there was a 76% acceptability rate, showing considerable operator improvement with practice.

On the basis of the tests, HAC concluded that the mode of descent used —a "perturbed gravity turn" trajectory —should be regarded as marginally practicable. The final pitchover maneuver at low altitude, which was required by the gravity turn trajectory, presented the two operators with a very difficult problem, resulting in a buildup of operator load scores to over 90% during the final 10 sec. of each run.

Knowles recommended that future landing simulation studies explore other guidance laws which would allow the pitchover to occur earlier and higher, and he also suggested use of visual cues combined with a predicted-landing-point display. Finally, he said the landing craft should have displays structured to allow one-man operation.

• **Lunar communications**—The problems of communicating not only to and from, but around, the Moon were laid out by M. Chatelain of North American Aviation. Stating that "translunar space communications can now be considered as a relatively simple problem," he pointed out some of the difficulties astronauts will face once on the lunar surface.

"Because the Moon is four times smaller than the Earth in diameter, the horizon is half as far away," Chatelain observed, "and the line-of-sight range is half what it is on Earth. The nature of the lunar surface also seems less favorable than that of the Earth for the propagation of surface waves. The lunar ionosphere—if there is one—probably has maximum ionization at the surface and cannot be used as a reflector of radio waves. Communications between two distant points on the Moon, or between a landing vehicle on one side and an orbiting vehicle on the other side, require the use of active or passive satellites."

• **Comsat choices**—Criteria for choosing between synchronous-orbit or medium-altitude communication satellites in random orbits were detailed by W. L. Pritchard of Aerospace Corp.

He suggested an interim system of random satellites and a later system of highly sophisticated synchronous satellites capable of handling very high-density traffic. Upon initiating operation of the synchronous system, he said, the medium-altitude system could be used simultaneously—either for backup in case of failure of the synchronous system, or merely to take advantage of the already-existing medium-altitude system and reduce the number of synchronous satellites required.

He advocated very close attention to the economics involved, and urged that multiple launches be made with each booster. He warned against the misconception that synchronous satellites inherently have a higher capacity than lower-altitude satellites.

• **Russians and Rumanians**—Soviet scientists Yu. M. Volynkin, P. P. Saksonov, V. V. Antipov and I. A. Savenko authored a general space radiation paper recommending a maximum permissible dose of 25 REM for astronauts involved in space missions of several days to one year. This figure, they explained, is based on calculated physical data correlated with radiobiological data concerning the injurious effects of ionizing radiation under terrestrial conditions.

"Transfer of these data to cosmic radiation without reservations is inadmissible; therefore, the recommendation should be regarded as temporary," they declared. "With the acquisition of experimental data on the biological effect on individual components of cosmic radiation on the effectiveness of radioprotective compounds, this dose will be altered." ■

ELDO Participants Report Brisk Pace

PARIS—European space launchings from Woomera, Australia, will be in a northeasterly direction and the ground guidance station controlling orbital injection of the payload of European Launcher Development Organization space rocket will be carved out of a tropical forest in Arnhem Land, northern Australia.

Reliable information from participants at the XIVth Congress of the International Astronautical Federation in Paris last week indicates that ELDO participants are making rapid progress in fulfilling national goals in the European space program.

Design of the ELDO rocket third stage, a German responsibility, will incorporate movable nozzles and will carry Netherlands-manufactured flight control subsystems.

The guidance ground station will be completely digital. Telemetry checkout tests will be conducted in Europe during the course of next year, and calibration tests using jet aircraft will be conducted over Arnhem in 1965. Jet aircraft at proper speed and altitude will cover the tracking route in the same time interval as the ELDO rocket.

During the Congress it became apparent that ELDO leans toward a sophisticated and reliable computerized radio command station as described in a paper by P. Polack of SEREB, the French IRBM agency.

• **Belgian leadership**—Polack described the necessity for high accuracy of localization of the vehicle during its powered phases, for rapid computer solutions and for non-delay transmission of radio commands to the space rocket. His paper was presented in a session chaired by M. Vigneron, head of Belgium's portion of the ELDO space rocket program.

Belgian companies identified for responsibility in fitting out the Arnhem station are:

- Manufacture Belge de Lampes et de Matériels Electroniques.
- Bell Telephone Manufacturing Company, Antwerp, a member of the ITT Europe, Inc., family.
- Ateliers de Construction Electrique de Charleroi.

The Arnhem, Australia, station will be located about 1,500 miles north of Woomera, well beyond the desert region into which the first ELDO rocket stage will fall to earth. The second stage will fall into the sea. Once the ELDO vehicle is about 165 miles from its launch point it will be 5 degrees over the Arnhem station's "horizon" and the vehicle's program will phase under control of the Belgian ground station.

It was learned in Paris that the French second stage as well as the German third stage have subsystems integrated with the Dutch-furnished sensor control equipment (attitude control) and flight control circuitry.

Spokesmen at the Paris meeting revealed that much of the responsibility for hitting the orbital keyhole rests on Belgian-German-Dutch development integration for the French and German upper stages, once the British first stage gets them on their way.

Significantly, officials from the Netherlands, Germany and Belgium will be meeting on just these integration subjects during October.

• **German rocket design**—By incorporating moveable nozzles into the German rocket plant, designers are confident the ELDO third stage when under power will be reliably correctable up to 25 degrees along its pitch and yaw axes.

As already reported, the first *Blue Streak DA* vehicle has arrived at Woomera for ground tests. A second de Havilland *Blue Streak* will be the first ELDO flight test vehicle and is due to arrive at Woomera in a few months.

The French-manufactured second stage is scheduled for flight tests at Colomb-Béchar late next year or in early 1965, with compatibility flights using the German third stage in mid-1965 to meet the ELDO target date for orbiting a payload in 1966.

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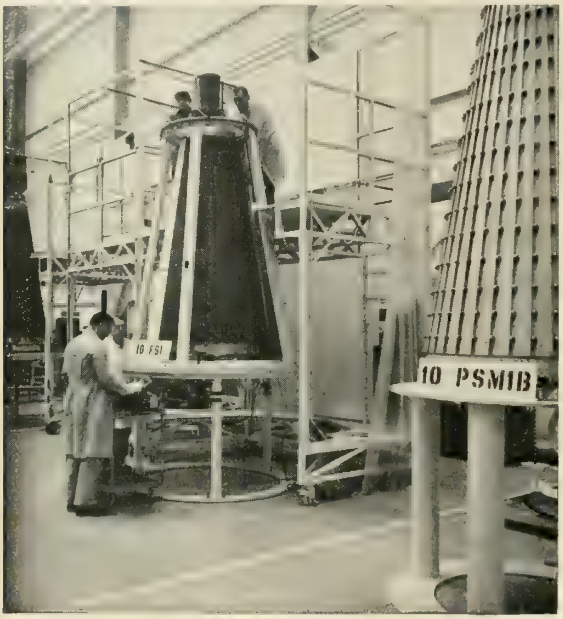


Fabrication of SNAP 10A systems at A.I.

Atomics International is a prime contractor for SNAP nuclear reactor systems for the U.S. Atomic Energy Commission. Responsibilities of the company include the entire SNAP 10A and SNAP 2 systems, as well as the reactor for SNAP 8. These power sources are designed to generate from 500 to 35,000 watts of electricity for a one-year period of unattended operation in space. Already several A.I. SNAP reactors have successfully passed their initial ground operating tests.

For the National Aeronautics and Space Administration, A.I. is studying the uses of compact nuclear power sources on the moon. To be determined: what design modifications would fit SNAP 2 and SNAP 10A for powering instruments and communications equipment on the lunar surface? Also, how could SNAP 8 be adapted to the power needs of a manned lunar base? SNAP applications might include lunar communications stations capable of operating for long periods unattended... perhaps a manned lunar experimental laboratory or astronomical observatory.

If you are interested in these and other rewarding challenges of space, the time for action is now. Opportunities now available in Atomics International's SNAP programs and other advanced nuclear work include the following:

SYSTEMS & CONTROL ANALYSIS — Analysis and simulation of complete nuclear power plants to develop reliable, automatic control and instrument systems to analyze reactor kinetics, dynamics, stability, thermal characteristics and reliability.

STRESS ANALYSIS — Provide stress analysis of compact nuclear power plants for space applications including review of all designs with respect to stresses resulting from thermogradients; transients, static loadings, vibrational and shock loadings.

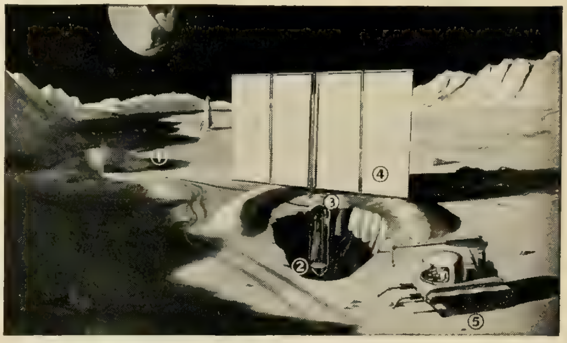
COMPONENT TESTING — Analysis of liquid metal heat transfer components in the SNAP 2/10A systems. Calculations involve knowledge of fluid flow, heat transfer, stress analysis and basic electrical engineering.

ENVIRONMENTAL TESTING — Plan and provide instrumentation for environmental tests of SNAP components and systems primarily for shock, vibration, acceleration, static loading and acoustics.

STRUCTURES — Analyze, investigate and physically test SNAP 2 radiator condensers and test fixtures to determine structural characteristics for launch loads, aerodynamic heating, shock and vibration.

DESIGN — Design high temperature, high reliability nuclear reactor auxiliary systems. Skills required in mechanical design, stress analysis and heat transfer.

Contact: Mr. H. K. Newton
Personnel Office, Atomics International
8900 De Soto Ave.
Canoga Park, California



Manned moon base illustrated at (1) would receive its power from SNAP reactor (2) beneath lunar surface. (3) shows power conversion units; (4) is radiator to dispose of excess heat. Roving electrical vehicle (5) would use SNAP power to charge its batteries.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

ATOMICS INTERNATIONAL

DIVISION OF NORTH AMERICAN AVIATION

Technical Countdown

ELECTRONICS

Apollo Simulator at Shawnee

Thiokol Chemical Corp.'s Shawnee Operations will develop and build a large three-axis flight simulator for testing of *Apollo* spacecraft control systems. The complete system, called a dynamic motion simulator, consists of a large gimballed flight table with integral hydraulic drives, and separate hydraulic supply systems and control console. When completed, the flight table will stand about 8 ft. high and be capable of testing large systems weighing up to 200 lbs. Yaw, pitch and roll rings can be rotated through 360 degrees without structural interference. Each ring is capable of a maximum angular acceleration of 3,960 degrees/sec./sec., maximum angular velocity of 40 degrees/sec., and minimum angular velocity of 0.002 degrees/sec. The $209,000 contract was awarded Thiokol by North American Aviation's Space and Information Systems Div.

Troposcatter System Successful

A tropospheric scatter system achieving fourth-order diversity using a single transmitter, receiver and antenna has passed all tests to date at Martin-Orlando. Tests were conducted earlier this year over a 214-mile link between Orlando and Tallahassee using both four frequencies spaced 2 mc apart and five frequencies spaced 1.5 mc apart. Data collected during 562 hours of continuous operation revealed an observed median signal some 4 db greater than expected with a 1-kw transmitter and 12-ft. antennas. Martin's time-frequency, spread-spectrum technique is a member of the RACEP family of pulse position modulation communications systems developed by the Orlando Division.

Weapons Systems Face Artificial Lightning

A 10-million-volt, portable lightning-producing unit is being built for the Air Force Special Weapons Center, Kirkland AFB, by Lightning and Transients Research Institute of Minneapolis under a $416,832 contract. The machine will be mounted on a five-ton trailer so lightning effects from its 50-ft. bolts can be studied at actual missile sites. The output will exceed 300,000 amperes—coming close to the natural level of about 500,000 amps. Early tests will involve a *Jupiter* missile to realistically evaluate the system before field usage. The purpose of the lightning tests is to measure the total effect of a bolt on an operational weapon.

ADVANCED MATERIALS

Superconductive Gold Alloy Found

A barium-gold alloy containing one part barium to five parts gold becomes superconductive at 0.7°K, according to a group of physicists at the University of California, San Diego. The alloys were used because the temperatures at which pure gold might become superconductive are too low to be reached by conventional cryostats. Results of the experiment were published in October *Physical Review Letters*.

Cryogenic Magnetostrictive Effects Studied

Physicists at Western Reserve University, Cleveland, are investigating a new magnetic effect in metals—the periodic variation in lengths of metal crystals at cryogenic temperatures as an applied magnetic field gradually changes. Dr. B. S. Chandrasekhar of Western Reserve had predicted that certain metals would show length oscillation dependent on the strength of magnetic fields at liquid helium temperatures. The metal rod should alternately stretch and shrink as the magnetic field is smoothly varied. A subsequent experiment with a single crystal of bismuth at −452°F, in a field of 30,000 gauss verified the hypothesis which was originally based on a theory proposed by the Russian Nobel prize physicist, Lev Landau. The Russian scientist had calculated the change in the energy of electrons in a metal when a magnetic field is applied. Magnetostriction is used in some submarine detection devices.

Largest Dead-Weight Testing Machine Designed

A 300,000-lb. stainless steel dead-weight testing machine is being built for the Bureau of Standards to calibrate standard load cells and force measuring devices, in turn, to calibrate instruments which actually check rocket thrust and other structural and material loads. Weights for the new machine are being fabricated by the Sun Shipbuilding and Dry Dock Co. from 200,000 lbs. of stainless steel supplied by Allegheny Ludlum Steel Corp. The new device is the first of five dead-weight machines scheduled for installation in the Bureau's new labs at Gaithersburg, Md. Plans are being formulated for another unit capable of reaching 1 million lbs. The 300,000-lb. machine will be accurate to within 0.005 of 1% in both tension and compression.

Refractory Coatings Developed

Arc-plasma deposited protective coatings have been developed for metals or alloys of tungsten, tantalum, molybdenum and columbium by Plasmakote Corp. These coatings are either silicides, aluminides, oxides or vitreous bonded crystalline ceramics. Their basic purpose is oxidation resistance through temperature ranges up to 4,000°F. The qualification tests were conducted on small rocket nozzles whose surface temperatures were maintained at a steady state temperature in excess of 4,000°F for cycles of one hour each. The techniques have been utilized on aerospace parts made of columbium with dimensions as large as 36 in. and are applicable to aerospace structures of any dimension or complexity. The structural integrity of the part is not jeopardized by the process.

SPACE OPTICS

Bulova Designs Sun Positioner

A new type of Sun positioner indicator is under development at Bulova Watch Co. for the *Agena/SNAP* satellite program. In addition to keeping track of the Sun, the instrument must withstand both space and *SNAP* generator radiation. The first unit will be a multi-faced device boom-mounted on the *SNAP* vehicle. The Bulova unit will weigh about 1.5 lbs. and use about 0.20 watts of power. Designed for a one-year space operation, the positioner is being developed by Bulova's electro-optical labs.

IBM To Build Flying Laser

The first laser optical communications system to fly aboard a manned orbiting satellite (*Gemini*), will be designed and built by IBM's Federal Systems division under a NASA contract. The Laser system will provide a one-way communications link from an orbiting spacecraft 100 to 300 miles above the Earth to a single ground receiving station. Contract for the prototype system totals about $80,000.

Doppler Study Holds Promise Of Improved Space Navigation

Raytheon tells AIAA that spaceworthy, precision Doppler navigator system is possible through spectral compression

by Rex Pay

PALO ALTO, CALIF.—A Doppler navigator system using spectral compression could measure spacecraft velocity to 0.04% accuracy, participants in a recent American Institute of Aeronautics and Astronautics Symposium here were told.

Chief benefit of the system would be its direct derivation of velocity during entry into planetary atmospheres—independent of knowledge of the geodesy or atmospheric structure of the planet.

Spectral compression makes possible a Doppler system that needs less electrical power and is more accurate than conventional Doppler, two prime requirements for spacecraft.

Feasibility of the system was revealed by an Air Force-funded study made by the Raytheon Company on Doppler for boost-glide vehicles.

Senior engineers Ralph G. McManus and James C. Rand of the company's Space and Information Systems division explained to the AIAA Symposium on the Engineering Problems of Manned Interplanetary Flight that the spectral compression technique involved varying the frequency of the transmitted signal in a way that compensates for the frequency spread in the signal returned from the ground.

If the transmitter frequency is modulated by a linear sawtooth waveform with a small parabolic component, the transmitted power needed for a typical spacecraft can be reduced from 240 watts to 5 watts. And since a transmitted power of 240 watts could require an input power of 1,000 watts, the reduction means a large weight saving.

This modulation also reduces fluctuation error by about seven times and terrain bias error by about 2,500 times in a typical spacecraft system.

- **Theory proved**—Confirmation of the theoretical predictions for spectral compression has been gained by in-flight tests with a B-26.

Doppler bandwidth develops because the finite beamwidth of the transmitted signal means that reflecting, or scattering, regions on the ground within the beam are moving at different velocities relative to the aircraft. In fact, the bandwidth of the returned signal is a function of aircraft velocity and antenna beamwidth.

What this means to spacecraft Doppler can be seen by estimating the effect of using an AN/APN 113 Doppler system in a boost-glide vehicle. This radar is used in the B-58 Hustler bomber and has an accuracy of 0.1% at speeds up to 2,500 ft. per sec. and altitudes of 10 miles.

In comparison, the boost-glide vehicle would fly at 25,000 ft. per sec. and altitudes of 100 nautical miles. The effect of going to this altitude would be to reduce the returned signal power by 20 db. And the increased velocity would smear out the returned signal over a wider bandwidth to virtually reduce the returned power by a further 10 db.

About 6 db. of this loss could probably be retrieved by increasing receiver sensitivity with the use of selected gallium arsenide crystals. These were not available when the Hustler radar was designed. A further 5 db. could probably be regained by use of optimum filtering techniques to improve frequency tracking.

But the rest would have to be regained by use of a larger antenna or by a 19-db. increase in transmitter power.

- **Size problems**—The antenna in the B-58 is a 2-ft.-dia. paraboloid, already large for spacecraft applications. Early estimates for the *Dyna-Soar* made 2 inches the maximum aperture permissible in the underside for antenna use.

And a straightforward power increase would incur a heavy penalty in weight.

The problem therefore becomes one of reducing the bandwidth of the returned signal. For the Hustler this bandwidth is typically a few thousand cycles per second. For the boost-glide vehicle, using the same Doppler system, the bandwidth would be more than 25,000 cps.

The means of reducing this bandwidth in the Raytheon system is to rapidly change the transmitted frequency in a cyclic manner. In this way the frequency return from each scatterer in the radar beam can be made equal to that for any other scatterer at any instant of time.

At first glance this looks as though it could be done simply by modulating the transmitted frequency with a linear sawtooth. But the fact that each individual scatterer on the ground takes up every position in the line of the beam means that a very slight parabolic component must be added to the sawtooth.

If the returned signal from this modified transmission is mixed with a portion of the transmitted signal and the phase of the resultant is differentiated, a beat-frequency signal results that has a very narrow bandwidth and provides an accurate indication of vehicle velocity.

The beat frequency can only occur at integrals of the repetition frequency. Therefore, the normal Doppler bandwidth can be reduced to a value no less than the sawtooth repetition frequency.

Also, because the system becomes a frequency-modulated radar, it is range sensitive, and to avoid spurious effects caused by range signals, the effective range resolution of the system should be made as high as possible.

If, for example, the total range difference from one edge of the beam to the other were 100 ft. and the range resolution were 10 ft., the maximum bandwidth compression ratio would be limited to 10:1. For higher compression, the range resolution would have to be increased. That is, the peak frequency deviation should be made as large as possible.

- **B-26 Tests**—To test the feasibility of the spectral compression idea, an experimental system was built and subsequently flown in a B-26. This aircraft does not simulate the behavior of a boost-glide vehicle very well, but was the best that was available.

Typical conditions for the test were altitude of 6,000 ft; speed, 207 knots; beam depression angle, 70 degrees; beamwidth, 2 degrees 33 minutes; basic frequency, 13.5 gc; and modulation period, 0.1 sec. In a conventional CW mode, the system yields a Doppler frequency shift of 3,286 cps and a bandwidth of 401.7 cps.

In the spectral compression mode, a beat frequency is obtained that theoretically varies from 21,529.29 cps at the leading edge of the radar beam to a minimum of 21,520.61 cps near the center, and back up to 21,530.51 cps at the trailing edge. That is, the bandwidth is reduced to 9.90 cps—a compression ratio better than 40:1.

Unfortunately, the range resolution of 7.7 ft. in a beamwidth range variation of 113.5 ft. would prevent compression of the spectrum by more than about 15:1 in the aircraft experiments. But in the boost-glide vehicle, this limiting feature would not apply because the range resolution would stay reasonably constant while the range variation in the beamwidth would increase greatly. So their ratio, which governs the compression ratio, would increase correspondingly.

For orbital conditions of 25,000 ft. per sec. at 100 n.mi. altitude, and a modulation period of 0.05 sec., the CW bandwidth of the system would be 23,711.8 cps, whereas linear and parabolic modulation would yield a beat frequency with a maximum variation of 471.6 cps. This represents a compression ratio of 50:1.

The peak transmitter deviation required would be 68.233 mc, and the range resolution would therefore be 21.6 ft. Because the differential range would now be 8,090.4 ft., the frequency compression is limited to less than 375:1, which is no restriction at all.

- **Other advantages**—There would be other benefits, too. Fluctuation error, caused by the noise-like nature of the returned spectrum, is a function of the square root of the bandwidth. It would therefore be reduced by the square root of fifty—or about seven times.

Terrain bias error, caused by the slope of the Earth's reflectivity coefficient, is a function of the square of the beamwidth. Because this has been artificially reduced by 50:1, terrain bias error is reduced by 2,500:1, claim Magnus and Rand. That is, to all intents and purposes, terrain bias error is eliminated.

Tests in the aircraft gave average bandwidth compression of between 9:1 and 12:1. This average was obtained over a 1-sec. integration period that included 15 full modulation periods and was governed chiefly by a human operator's ability to adjust the shape of the modulation characteristic to meet changing conditions of velocity, altitude, pitch and roll in the B-26. At times this characteristic was adjusted much better than others, achieving as much as 36:1.

In an operational system the modulation adjustment would be carried out automatically, to achieve a consistent high performance.

The expected accuracy of this system would be 0.04% in the indication of velocity, the measurements for the basis of this prediction having been obtained on the Raytheon Boresight Range.

In the experimental system, the basic modulation-period waveform originates from a small audio oscillator. Pulse-shaping circuits provide the necessary re-set commands to the linear and parabolic waveform generators. These are resistance-capacity networks used along with high-gain operational amplifiers.

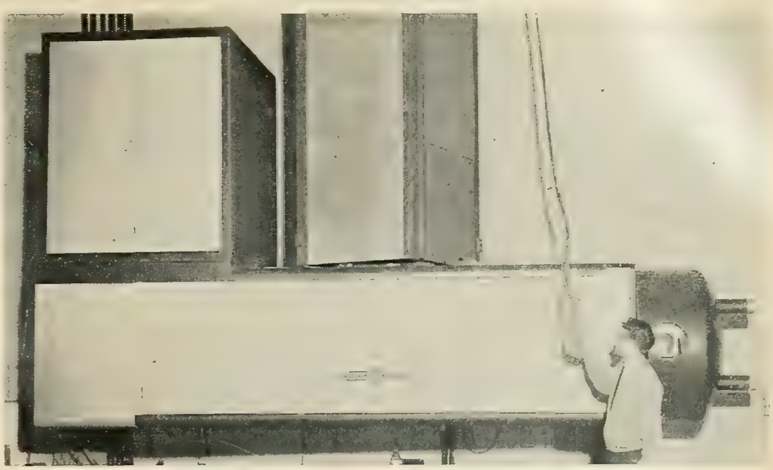
The resultant voltage waveform is applied to a closed-loop, voltage-controlled oscillator operating at about 9.259 mc. Closed-loop operation of this oscillator holds it to within 0.02% of linearity.

Subsequent multiplication raises the frequency-modulated signal to about 500 mc. It is then applied to a varactor radio-frequency multiplier to give a signal at 13.5 gc, along with the required deviation of 200 mc. Amplification by a TWT follows, after rejection of undesirable harmonics by means of a waveguide filter.

A space-duplexed transmission was used with the antenna pointed aft along the aircraft center line at a depression angle of 70 degrees.

A homodyne receiver (zero intermediate frequency) eliminated the need to develop a wideband single-sideband generator with good carrier and unwanted sideband rejection over a frequency deviation of up to 200 mc.

The beat frequency from the video amplifier of the receiver was recorded on tape for further ground evaluation as well as being viewed on a frequency analyzer in the aircraft. ■



Linear Accelerator at Hill AFB, Utah

MINUTEMAN RADIOGRAPHING time has been cut from 316 to 21 hours with this 24-million-electron-volt linear accelerator at Hill Air Force Base, Utah. Each time a Minuteman is brought in for maintenance it is radiographed to detect flaws in the propellant or in the bond between the propellant and the casing liner. Flaws as small as 0.1 in. in diameter can be spotted at a depth of 10 in. using the Varian Associates-built device. To provide the rated output of 25,000 rads per minute at one meter, RF power for the accelerator is obtained from an S-band klystron.

Martin techniques for solving the problems of life support in space

1. **In Martin equipment studies,** we test safety and operation of protective clothing in environmental control chambers which provide a wide range of temperature variations. Mounted over a variable speed, variable pitch treadmill, this chamber checks equipment under conditions of exertion as well as repose.

2. **In Martin simulators,** we put men through rigorous computer-programmed "flights" which duplicate every condition of a space mission but weightlessness. Purpose: to evaluate man's performance under these conditions and to verify the sub-systems he needs to assure completion of his mission.

3. **In Martin life science laboratories** we are developing and testing reliable systems for maintaining a breathable atmosphere. Shown here is GIPSE, a fully instrumented Photosynthetic Gas Exchanger, being installed in the passenger pod of a space vehicle for actual test in space. Successful test flight took place in March, 1963.

4. **In Martin design studies,** we conduct detailed tests for optimum control cabin configuration. Pilot shown here is running a simulated lunar landing problem using an in-place diagram of one possible control panel arrangement.

5. **At Martin's Rendezvous Laboratory,** we use full-scale computer-programmed simulators to develop precision techniques for rendezvous of orbiting spacecraft. Triple exposure shows progress of spacecraft making approach and closure for docking under simulated space conditions.

These are just five examples of the techniques we use to provide answers for life support in space, where man is the prime system. Current Martin research includes the basic life sciences, the development and application of equipment and instrumentation, the chemistry, physics, metallurgy and mathematics of life support, and the entire broad area of Man-Machine Integration. Our extensive range of facilities and capabilities gives us the unique opportunity to integrate all aspects of the problem. Life support is an area of major capability at Martin.

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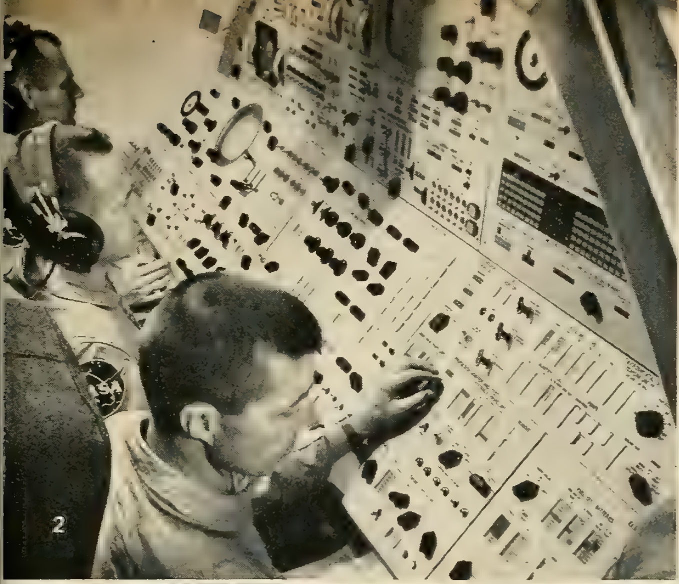
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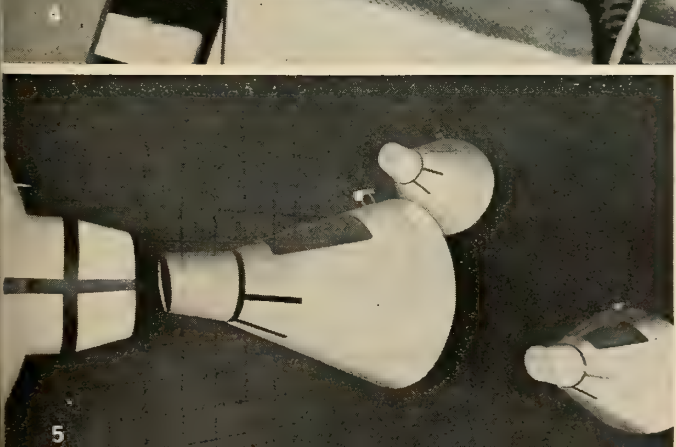
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MARTIN
MARTIN MARIETTA

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Silicone Rubber Sponge May Encapsulate Electronic Components

by John F. Judge

New Haven, Conn.—A room-temperature-vulcanizing pourable silicone rubber sponge system is in the early development stages at Connecticut Hard Rubber Co. The sponge material is being evaluated in working experiments for electronic component encapsulation.

The high-density sponge is capable of being fabricated in complex shapes with potential applications in shock mounting and insulation. The sponge maintains good physical properties for a silicone.

CHR specialists are quick to point out that the material is not merely a silicone foam, but is truly sponge-like. The material also has good handling characteristics. The fabrication process is proprietary information at CHR, but does involve catalytic action.

The material consists of a number of interconnecting cells. One result of the processing is the natural formation of this partially open cell structure within a solid surface skin.The skin itself provides additional abrasion and water absorption resistance.

The CHR formulations maintain constant, uniformly low compression set characteristics through three basic compounds—soft, medium and firm. The complexly shaped sponge can be provided in flat sheets or in intricate configurations.

Where resistance to tear and abrasion or low friction, anti-stick characteristics are desired, CHR can fabricate the material in combination with other materials such as elastomers, plastics, metals, ceramics or coated-on fabrics. Teflon and Dacron-covered complexly shaped sponge seals can be made.

- **Seal history**—CHR is a veteran in the aircraft industry, having supplied various seals for both commercial and military aircraft since 1939. Besides this experience in sealing methods and allied materials, the firm is capable of manufacturing plastic reinforcements through vacuum bag, pressure bag, autoclave and hydroclave methods. A 6 x 15-ft. autoclave, with pressure and temperature limits of 300 psi and 450°F, recently went into operation at the firm's New Haven facility.

CHR spokesmen admit the firm is still in the early stages of reinforced plastics manufacturing, and that the current program calls for a gradual increase in capability in this area. But there is a depth of experience in polyester, epoxy, phenolic and silicone resin binders, together with glass reinforcements. The manufacturing process is largely hand lay-up coupled with the various curing methods—which gives CHR a good market position in low-production-run complex parts.

Reinforced plastic components have been produced under various contracts, including *Nike-Zeus* waveguide covers, camera defogging ducts, electronic system cooling ducts, thyratron tube covers and electronic circuit components.

CHR's major forte is aircraft seals, and the firm has supplied almost every type and configuration known. The work in this area has led to a familiarity with a host of new engineering materials, and this experience paved the way to the contract for the *Mercury* capsule impact skirt.

With high-production aircraft a thing of the past, CHR has been turning its materials and processing capability to the missile/space field and now functions as a custom fabricator.

The firm's current equipment includes mills, extruders, vulcanizers and presses, in addition to the autoclave. There are also specialized pieces of equipment such as fabric coating towers, tape slitters, high-temperature ovens and duct-building machines. ■

COMPLEX SHAPE SPONGE TEST METHODS (ASTM-D-10056-597)

PROPERTIES (GENERAL)	COHRlastic M-915 (soft)	COHRlastic M-922 (medium)	COHRlastic M-923 (firm)
COMPRESSION DEFLECTION to 75% of Original Height			
at Room Temperature	2–6 psi	6–12 psi	12–18 psi
at −65°F.	2–6 psi	6–12 psi	12–18 psi
at 212°F.	2–6 psi	6–12 psi	12–18 psi
After 5 hrs. @ −65°F.	2–6 psi		
After 22 hrs. @ 300°F.	2–6 psi		—
After 22 hrs. @ 350°F.	2–6 psi		-
COMPRESSION SET			
22 hrs. @ 70°F.	5% max.	5% max.	5% max
22 hrs. @ 212°F.	10% max	10% max.	10% max
22 hrs. @ 350°F.	15% max.	15% max	15% max
22 hrs. @ −65°F.	5% max.	5% max	5% max.

COHR M-915 (Specific Properties)

DENSITY (lbs./cu. in.)	0.913
COMPRESSION DEFLECTION	
Measured at R.T.	3.1–4.5 psi
Measured at 212°F.	4.2–4.4 psi
COMPRESSION SET	
After 22 hrs. @ R.T.	0.4–2.6%
After 22 hrs. @ 158°F.	0.4–2.8%
After 22 hrs. @ 212°F.	1.6–4.7%
After 22 hrs. @ 350°F.	4.4–13.9%
HEAT AGING	
VOLUME CHANGE	
After 72 hrs. @ 350°F.	2.1–2.4%
After 72 hrs. @ 450°F.	3.6–4.0%
COMPRESSION DEFLECTION	
After 22 hrs. @ 302°F.	3.2 psi
After 22 hrs. @ 347°F.	3.2 psi
After 72 hrs. @ 450°F.	4.5–5.0 psi
WATER ABSORPTION	
Weight Increase	2.4%
LOW TEMPERATURE BRITTLENESS	
No Cracking	Pass

TEST CONDITIONS
The properties of the sponge compression deflection are not a function of the sponge density.

COMPRESSION DEFLECTION
Compressed to 75% of original thickness tested per ASTM-D-1056-59T

COMPRESSION SET
Compressed to 50% of original thickness tested per ASTM-D-1056-59T.

WATER ABSORPTION
A 2 x 2 x ½-in. test specimen immersed in water for 24 hrs. at room temperature

Requirements for Manned Interplanetary Journeys Outlined

by Michael Getler

MIAMI BEACH, FLA.—The transition in the U.S. space program as it advances into more sophisticated manned space flight and interplanetary programs was strongly in evidence at this year's National Space Electronics Symposium, held here early this month.

Heavy emphasis was placed on electronics requirements for interplanetary exploration and communications. The recent flow of major *Apollo* subsystem engineering information (M/R, Oct. 7, p. 54) also continued, with details presented on the telecommunications network.

About 1,100 persons attended the four-day meeting.

Communications requirements for manned interplanetary missions, judged to be still about two decades off by many scientists, were outlined at the meeting by NASA's Ralph S. Sawyer of the Manned Spacecraft Center.

Sawyer reports that though certain *Apollo*-type systems—such as VHF voice links, HF recovery systems and intercoms—may find universal application in manned space flight, major new efforts would be required to overcome problems peculiar to interplanetary flights. The problems include signal attenuation, propagation time, and inherent weight and power difficulties.

Round trip missions to Venus and Mars would take about 400 days.

Essential to reduced complexity in handling the full range of communication functions—tracking, data acquisition and transmission, voice communications, and TV—is a unified carrier, or frequency, link. This presumably would be patterned after the S-band link that will serve *Apollo* in deep space phases.

- **Tracking**—By using pseudo random-code techniques in the primary tracking function, Sawyer says it is possible to provide range at interplanetary distances with a theoretical accuracy of ± 15 meters and a resolution of better than 15 meters. Two-way radial Doppler operation for real-time velocity determination should be available at all ranges, with an S/N ratio sufficient to maintain carrier lock.

To accomplish tracking at these ranges, the spacecraft will require coherent transponders, high-gain directional antennas, power amplifiers, and a ranging unit on both the mission and excursion modules. This ranging unit, Sawyer says, should be a code-regenerating device that eliminates noise from the received signal before re-transmission. A simpler "turn-around" system could be used for near-Earth phases.

The antenna system would require an Earth sensor to achieve the 35-db gain, which Sawyer says is realizable with about a 10-ft.-dia. system at long ranges. The system would also be stowable.

An integrated rendezvous and landing radar would also be required for operation in the vicinity of the planet. For rendezvous, Sawyer envisions a cooperative system using a single beam of either coherent pulse or interrupted CW transmission with a 50% duty cycle.

Interferometer techniques would be used for angular measurements. Sawyer says this radar could be implemented either as a mode of the landing, or altimeter, radar, or through the unified carrier transponder.

X-band is a likely choice for the radar altimeter because of proven componentry and higher gain possibilities, though power problems at this band at long ranges still exist. Single-beam pulse-radar techniques would be used for high altitude, with multiple beams using FM/CW or ICW for the close-in measurements. Sawyer anticipates that the angular pattern of multiple beams will aid in minimizing effects of exhaust plumes and planetary dust.

Techniques similar to these, such as interferometer rendezvous methods and multiple beam landing radars, will be used on *Gemini* and LEM, respectively.

Specialized T/M Systems Detailed

NASA SCIENTISTS from the Langley Research Center revealed details of a new 1,000 watt, X-band re-entry telemetry system that weighs only 3 lbs. at the IEEE meeting. The system, which will be used in NASA's *Trailblazer II* re-entry vehicle study, is a miniaturized version of the system used in Project RAM tests.

The device, solid-state except for the magnetron transmitter, reportedly can withstand accelerations greater than 100 g's and can transmit through black-out at high data rates from vehicles traveling at speeds in excess of 25,000 ft/sec.

The system uses time-division multiplex techniques with pulse-position modulation. Data capacity is 900 samples per sec.

Scientists from Sandia Laboratory described design of the high-resolution rocket telemetry system used for transmission of sensor-derived radiation data to ground stations during the Dominic series of high-altitude nuclear detonations.

The system reportedly provided a 55-mc bandwith FM microwave telemetry channel between rockets in adverse radiation environments and a ground station that was about 10^5 meters from the rockets. Inherent resolution of the system, excluding the sensor, was reported to be within the 10 nsec spec.

The basic T/M system, which operates for about 15 minutes, consists of a klystron oscillator, TWT amplifier, GMD beacon, timer control circuity, power supplies, and battery. TWT output is fed to a 3-db beamwidth horn antenna.

• **Data link**—Mission geometry poses many problems. For example, in planetary orbit, direct line of sight with Earth will be limited to about 50% of the time in orbit. The LOS between mission and excursion module is even lower, about 15-20%.

Sun, Moon and the planets will also cause increased noise factors. Data must be stored until it can be transmitted. Also, since the crew must have virtually complete command capability on these missions, on-board data processing and extraction are essential.

What is needed, says Sawyer, is a tape recorder-reproducer system that should emphasize minimum error in preference to high data rates. Low data rate PCM systems are being recommended in the deep space phase, with capability for higher rates near Earth and intermittently throughout the mission when in high power mode. Data is expected to be bi-phase, modulated on a high-frequency sub-carrier which, in turn, is phase modulated on the unified link.

It has been calculated that it is possible to transmit 100,000 bits per second from Mars and Venus using a 100-watt transmitter, 10-ft. spacecraft antenna, and 210-ft. ground receiving dish. A low-data-rate mode, including voice and minimum data functions, could probably perform with about 10 watts, Sawyer reports.

• **Voice**—The disconcerting effect of the time lag would be most noticeable in voice communications at deep space ranges. Because of this, voice could be eliminated by some form of teletype system. It would take about 10 minutes round trip voice time.

In choosing any non-voice transmission technique, NASA says consideration must be given to the type of data involved. Data of a predictable nature could be programmed into the PCM telemetry link. Unpredictable events, such as a discovery, would best use a non-voice low-data-rate system yielding improved accuracy within a narrow bandwidth.

• **Television**—TV from deep space will have to undergo considerable bandwidth reduction, even beyond the major reductions made in the *Apollo* TV scheme before it becomes feasible. The *Apollo* system from deep space would take an estimated 1,000 watts. NASA says it is now primarily concerned with means of efficiently encoding the TV signal and eliminating much of the redundancy inherent in a conventional video signal.

TV bandwidth compression currently represents a major part of an overall NASA program to compress BW requirements for several functions. Processing using vocoders, comb filters, and redundancy sensing and elimination techniques are being studied.

Laser techniques, both for optical communications and radar use, are getting current emphasis among NASA's advanced studies in interplanetary manned missions.

Analysis at MSF showed that for interplanetary Earth-space optical links, at least one if not two comsats, synchronous with the objective planet, would be required. Optical radar, they say, holds promise of penetrating exhaust plumes and re-entry plasmas, and in a docking system with wide-beam techniques.

Other schemes for interplanetary exploration presented by engineers from Sylvania Electronic Systems and Hughes Aircraft Co. also drew interest.

Sylvania engineers reported that as a result of satellite measurements and other new data, there was mounting evidence that attenuation bands centered in the VLF part of the spectrum exist around the planets and Sun by virtue of their ionized atmospheres. In essence, these atmospheres will act as shields and produce very low noise levels at VLF in deep space.

If this is correct, and the engineers say more direct measurement is needed, reliable communication bandwidths over deep space ranges may be obtained on a point-to-point basis at low power and with omni-directional antennas.

Antenna tracking problems are eliminated. Frequency searching problems and Doppler compensation are simplified at VHF, they report. Also, the number of relay satellites in heliocentric orbits required to grid all of interplanetary space out to Jupiter is reduced because of the "long haul characteristics" of VLF.

• **Exhaustive laser study**—A scheme for a laser deep-space communication system, presented by engineers from Hughes, attracted major interest at the meeting. It was of interest both because of its design and because of the massive survey of the current laser state-of-the-art it represented.

The paper is an outgrowth of a study performed by Hughes for NASA in which more than one thousand papers were reviewed, according to the authors.

The communications system that evolves within the study as the design most feasible to implement in the near future is a pulse code modulation/polarization modulation system using a CW gas laser.

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Motion study. Induced rotation of a Manned Orbital Research Laboratory under study by NASA, which would provide artificial gravity for its crew, could also introduce unwelcome twist, tumble, spin and wobble in space. ☐ Because these motions can best be arrested by precision stabilization, Sperry is under contract to NASA Langley Research Center (1) to make dynamic analyses of the types of motion which may be encountered; (2) to derive control laws which may be applied to the resultant problems; (3) to generate control concepts which will guarantee station stability. ☐ Because orbital times up to a year are under study, a manned station presents a unique challenge in control. Sperry experience in gyroscopics, aerospace control, undersea stabilization logically suits us for the task. General Offices: Great Neck, New York.

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nificant advantage over microwave systems for night transmission (situation reversed for daytime).

A 25-mw average power gas laser, Hughes reports, will permit transmission of 750 data samples per second at night, compared with 14.3 for a roughly equivalent microwave system.

Discussions of *Apollo* communications by NASA, North American Aviation, Inc., *Apollo* prime, and Collins Radio Co., major subcontractor to NAA for telecommunications, revealed details of both the design approach, judged to be conservative by NASA, and the hardware now under development.

- **Apollo system fairly firm**—Design of the system is reported to be basically firm, though there are some uncertainties concerning component selection (which type of S-band amplifier tube to use), and final antenna configuration and location. Also, the completed plan for communicating with the spacecraft during the transition period between near-Earth and deep space links (about 2,000-10,000 miles) is still unresolved. A decision is pending on adding one or two more S-band tracking links (30-ft. dishes) to the existing S-band *Apollo* network (M/R, July 8, p. 33) to fill gaps in the capabilities of current 85-ft. dish stations. Maintenance of voice and telemetry links during this period is judged by NASA to be more critical than maintenance of track.

Rather than increasing the range of current near-Earth voice, telemetry and tracking capabilities by ground equipment modification, NASA reportedly also favors using the unified S-band transponders aboard the spacecraft at distances above the 2,000 mile altitude at which the near-Earth links begin to reach range limits.

For near-Earth operation, in its current configuration, the *Apollo* spacecraft contains a VHF-FM transmitter for down-data transmission and a C-band transponder to aid in ground track.

An intercom, signal conditioners, PCM telemetry system, and data storage equipment are used in all phases of the mission.

Once beyond 8,000-10,000 miles from Earth, all communications between the command module (CM) and the Ground Operational Support System (GOSS) are maintained through the use of a phase-coherent unified S-band transponder and associated power amplifier. This transponder receives and retransmits pseudo-random noise ranging signals, it receives voice and up-data, and it transmits telemetry, voice, stored data and TV. Both a non-directional and a high-gain Earth-tracking S-band antenna are provided.

VHF and S-band links involving the LEM and astronauts on the lunar surface were first revealed in M/R, July 15, p. 22.

Missile/Space Velocity Measurement Would Apply Nuclear 'Resonance' Rule

ENGINEERS from the Martin Co.'s Baltimore Div. reported to those at the IEEE meeting on efforts aimed at developing a prototype of a precise velocity measurement device for missile/space use. Accuracy would be independent of variations in the transmitting environment through application of the Mossbauer effect of nuclear "reasonance" at gamma frequencies.

In RF Doppler systems, where accuracy is independent of signal amplitude above a minimum value, the minimum amplitude is adversely affected by attenuation and refraction. By operating at gamma frequencies (10^{19} cps), these perturbations present no significant problems. Martin reports, however, that it was not possible to measure Doppler shifts at these frequencies until recently.

The Mossbauer effect, they report, allows quantitative measurement of Doppler shifts to one part in 10^{12}.

In 1958, Rudolph Mossbauer discovered a method to produce monochromatic gamma radiation by binding source nuclei in a crystal structure so that a virtually recoilless emission results. This implies that an absorber of like material would absorb this emission when the relative velocities of the source and absorber are zero.

Using this type of system, according to the engineers, velocity changes of a fraction of a centimeter per second can be distinguished, with the associated electronics required probably introducing the majority of basic system error.

- **Hardware described**—Key elements of the hardware required to implement the extensive communication network were described in a joint NAA-Collins Radio presentation.

To meet requirements for omnidirectional VHF coverage during near-Earth phase, a pair of scimitar antennas is mounted on opposite sides of the CM, with a multiplexer used to properly combine signals. Four transmit channels and one receive channel are provided. The multiplexer uses tuned cavities, providing a minimum 40-db isolation between channels.

For C-band tracking out to about 4,000 miles slant range (depending mostly upon antenna performance), a new type of C-band transponder using amplitude comparator techniques was developed. Device has a 2.5-kw peak power output.

The associated antenna sys[illegible]cludes four right circularly po[illegible] flush-mounted quartz-loaded anten[illegible] equally spaced around the CM. The antennas, which provide virtually complete spherical coverage, are coupled through circulators to four receivers so that each receiver continuously monitors the incoming signal of its antenna.

The unified S-band equipment carried on board consists of the transponder and power amplifier. The transponder is a phase-coherent, phase-locked receiver and transmitter in which phase coherence is obtained by using a common oscillator.

A traveling wave tube, plus its power supplier, forms the heart of the amplifier. The device has 20-watt and 5-watt output levels, the former for wide-band use such as TV or HF analog data, and the latter for normal operation.

Switches are included to enable the transponder-driving signal to bypass the TWT and be fed directly to the antenna if desired. A diplexer is also contained in the unit, which enables the transmitter and receiver to share the same antenna. Because of the critical nature of this subsystem, a back-up program to develop an electrostatically focused klystron has recently been initiated, with a decision due after qualification testing.

Both the non-directional S-band antennas have been built into the VHF scimitar antennas, taking the form of slots cut into the antenna surfaces.

- **Unique antenna**—The high-gain S-band antenna is somewhat unique because of its location, in that it must withstand high temperatures (above 2,000°F.) generated by one of the *Apollo* attitude-control engines. The antenna, which is stowed and then erected in flight (it cannot be stowed again), is built of a high-temperature Columbium alloy.

The antenna is a 16-element array, with provision for using fewer elements for reduced gain and increased beamwidth.

By using various element combinations, beamwidths of 25, 11, and 6.5 degrees are achieved with corresponding gains of 14.5, 21, and 27 db. Earth sensor for the system operates in the 14-22 micron region with 2 degree and 40 degree fields-of-view.

Apollo's TV system includes an analog TV camera using a 1-in. electrostatically focused vidicon. The camera weighs only 5 lbs., requires about 6 watts, and uses both zoom- and wide-angle lenses. The 320-line, 10 frame-

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- **NRL proposes refinement**—U.S. Naval Research Laboratory, developers of the space surveillance system that stretches across the southern U.S., reported on a highly successful new scheme for combining phase channels from a compound multi-baseline radio interferometer system—such as the space detection net that yields major performance and data handling benefits.

In effect, the NRL system automatically combines several noisy ambiguous channels into one unambiguous quiet channel. In multi-baseline radio interferometer systems having high angular resolution capability, deciphering the multiphase signal outputs is generally a problem.

With the new combiner, NRL says a single unambiguous channel can be instrumented with an output that has an accuracy and resolution proportional to the longest baseline in the interferometer, and whose noise content is inversely proportional to this baseline.

The single channel depicts the angle of arrival of the radio energy from the satellite in real time.

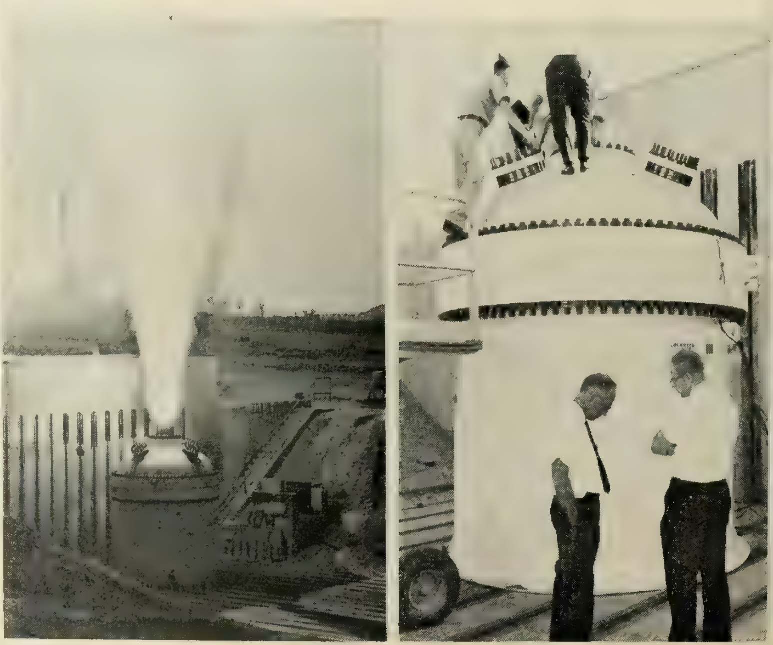
With the system now in operation (basically with east-west baselines) field tests have been described as satisfactory. Future plans call for combining North-South baselines in conjunction with the east-west to determine satellite direction and velocity.

- **Other developments aired**—Engineers from the Bendix Corp's Research Laboratory Div. presented a scheme for a new radar-computer system that permits selection of a lunar or planetary landing site during the terminal descent.

The concept combines a high resolution X-band FM/CW radar with a signal processor that operates on the signals from parallel narrow-band receivers to evaluate proposed landing sites.

Martin Co. engineers from the Denver Div. reported development of an optical radar system for rendezvous and docking use.

Martin says the radar has been built and tested using 10% of maximum input power. In this configuration, search, acquisition, and track capabilities at ranges to 0.8 mile in the atmosphere in daylight were noted. Angular resolutions of one milliradian were demonstrated at short ranges, and tracking capability was reported achieved at ranges down to three feet. ■



Lockheed 'Char' Motor Allows Repeated Firings

REPEATED FIRINGS of uncured solid propellants are possible in this huge "char" motor designed and built by Lockheed Propulsion Co. for the Air Force's rocket propulsion lab, Edwards AFB. The re-usable motor will be utilized to test nozzle and control elements under conditions comparable to those existing in the firing of a case-bonded solid rocket motor.

Pershing Overland Firings Near Completion

SUCCESSFUL shot in recent series of Pershing launches by troops of 2nd Missile Bttn., 44th Artillery, into White Sands Missile Range, N.M.

by David C. Breasted

White Sands, N.M.—The Army plans five *Pershing* missile firings this week from Ft. Wingate, N.M., to White Sands Missile Range to complete the first series of missile test flights over populated areas within the United States.

The firings, for distances of from 150 to 230 n. mi., are designed to verify the predicted performance tables in the lower end of the Martin *Pershing* range spectrum of 100 to 400 n. mi.

Barring long-odds mishaps, optimism is high that the Wingate shots will be "in the pickle barrel," like five last month from Blanding, Utah, to White Sands. Ranges in that series varied from 275 to 350 n. mi.

"We're really getting the stuff we expected from the system," said one project officer.

The two-stage solid tactical missile system appears to be moving smoothly toward operational status. First tactical equipment was delivered to U.S. troops in December, 1962. West Germany is buying the missiles.

- **Test objectives**—Primary purpose of the New Mexico series is to establish the accuracy of flight data programmed for computer input and to test how well the missile system performs with the data. This includes the tiltover and reference trajectory programs.

Army spokesmen close to the operation said they were pleased with final data from the first four firings and with preliminary data on the fifth. They were also gratified with results of a second objective—testing performance after tactical maneuvering in rugged country and long road hauls to the firing positions.

The two-phase series is the first time the *Pershing* has been fired with its tactical equipment in conditions approaching those of the battlefield. Crews were tested on how long they took to set up and fire in the field.

Furthermore, there have been smooth solutions of the knotty problems of dealing with state government officials and Congressional delegations, and arranging for compensated evacuation of inhabitants from booster impact safety zones downrange from firing.

- **Launch schedule**—In the current series, firings are scheduled for Oct. 14, 16, 18, 21 and 23. The planned ranges are 150, 179, 190, 200 and 230 n. mi., although not necessarily in that order. There is a possibility that "a couple of extra shots" may go.

Altitude of Wingate is about 6,000 ft., and that of Blanding is 8,000. Impact elevations vary from 4,000 to 5,000 ft. on the White Sands Range. Latitude and longitude data also are different from previous testing at Cape Canaveral.

During a two-week delay in the Blanding shots, caused by complex problems of range instrumentation and data hookups, crews took the test missiles aboard their tracked carriers and support vehicles on maneuvers in rough terrain northwest of the firing position.

Effects of this and overland transport were reported to be minimal. Only holds were one range hold, and a day's delay because of trouble in one interior cable connection.

- **September series results**—On a condensed schedule, including two firings on one day during the Blanding series, one missile travelled 350 n. mi. to impact in the McGregor Range southeast of White Sands.

Two others covered 300 and 320 n. mi. The last two were 275-mi. firings to the same impact point at White Sands.

Average flight time for the five shots was about seven minutes.

The operation involves setting up an intricate communications, range safety and computer data net between the firing position and White Sands. Surveillance radar to warn off intruders serves in addition to ELSSE radars, one aimed downrange and the other at right angles to the trajectory.

The missiles carry small telemetry packages and radar re-electors, but otherwise closely resemble the combat version.

Performance of the reliable *Pershing* in the current series comes as no surprise to the Army. It has been tested exhaustively at Cape Canaveral.

But data gathered during the September firings now under evaluation by the Army's Artillery Board was described as "beautiful." ■

Upcoming Tests May Determine Nuclear Rocket Reactor Design

Westinghouse/Aerojet, Los Alamos Scientific Lab prototypes face first cold-flow tests in December; Finger outlines program gains

by Robert Lindsey

PALO ALTO, CALIF.—After a year of review and "re-grouping," the nation's nuclear rocket program now faces a series of tests that could be the technical moment of truth for the reactor design chosen for Project Rover.

Harold B. Finger, NASA's chief of nuclear systems, told the AIAA conference on engineering problems of manned interplanetary exploration here: "During the past year, we have made substantial gains in the technical understanding of the problems (delaying the reactor development) and how to solve them. We now have greater confidence than ever in our ability to develop a nuclear rocket."

However, he said the first flights of *RIFT* (reactor in-flight test) vehicles are possible now "at the earliest, very late in this decade or in the early 1970s." He said early estimates of a flight in 1966-67, announced as a NASA target, were "wishful thinking."

• **Hot shots next year**—Finger said that cold-flow tests are planned in December on the two reactor prototypes now in the program. If these prove successful, hot firings will be conducted "during the first half of next year."

Since the last firing of the Kiwi B4-A reactor at Jackass Flats, Nev., in November, when unexplained flow-induced vibrations cracked fuel elements and caused serious damage to the system, he said a double-pronged, new line of attack has been applied to the program:

—Westinghouse and Aerojet, contractors for the *NERVA* engine which will use the Kiwi reactor, were authorized to develop a second reactor, similar to but competitive with the design of Los Alamos Scientific Laboratory.

—There has been a "greatly expanded" program of component tests and analysis to lay the foundation for hot tests.

Studies to learn the source of the vibrations, he said, have been "extremely successful." One major advance, he noted, was learning that vibration dynamics can be duplicated and studied during cold-flow tests. He said valuable data was produced in two cold-flow tests at Jackass Flats, and use of a 60° sector of the LASL reactor has also proved helpful in simulating vibration.

He cautioned: "Although we believe we are well on the way to solution of the vibration problems, the solution could bring on other problems." But he stressed, "These are engineering problems and they can be solved with good engineering."

• **Engineer shortage**—Asked by MISSILES AND ROCKETS if the Kiwi problems can be attributed to too many scientists and not enough engineers, Finger conceded this has been the case "to some extent." But he paid tribute to LASL, which he said conceived the basic design of the system, established an understanding of nucleonics, established capability to start up the reactor and solved many other problems basic to the design.

Finger declined to detail the differences between the reactor designs for security reasons, but he said they are subtle. "They are very similar in basic core configuration. They take different approaches to solution of the vibration problem."

Designation of the Westinghouse-Aerojet reactor is NRX-A.

Both reactors, Finger said, will produce 1,000 megawatts, and in the *NERVA* engine will generate 50,000 lbs. of thrust at a specific impulse of 700 seconds.

Finger said he has confidence in the basic reactor design. "I don't know which of the two it will be; I personally think it will be a combination using features of both. I think both will have some troubles, but in the end, I think they will blend into a single system."

• **Reactor is pacing item**—Finger said other facets of Project Rover are being held up until the reactor problems are solved. "There's no need to go full bore on the hardware; we'll hold back until the reactor is ready."

For example, he said, Lockheed Missiles & Space Co., contractor for the *RIFT* stage, is now being limited to a level of about 400 employees.

Finger said interplanetary flight continues to be the most obvious mission for nuclear rockets, but he stressed its role in upgrading the *Saturn V* for various missions and prolonging its life should not be disregarded.

He proposed a possible mission of a Mars unmanned orbital flight with a television system in a 25,000-lb. payload. He said a *SNAP-8* would prove an ideal power supply. Perhaps, he said, the mission could include an optional remote landing vehicle. ■

Stringent Safety Tests Set for NERVA Reactor

ALBUQUERQUE, N.M.—The *NERVA* thrust chamber and reactor model will be deluged by a vertical wall of water accelerated to a speed of about 200 fps. by a rocket sled on the 3,000-ft. track at Sandia Base, N.M.

Purpose of the test is to investigate effects upon the nuclear rocket of water impact after an abort during launch. Catastrophe might result if the water impact makes the reactor go critical by crushing the reactor core into the front end of the chamber. This is done deliberately to trigger some atomic bombs.

Another danger is that water flooding into propellant passages of the reactor might cause it to go critical by acting as a moderator.

• **Model poised**—The *NERVA* model is already on the track site at Sandia and the water carrier is being prepared. The model will be mounted at the end of the track with the open end of its bell-mouthed nozzle facing the onrushing sled.

Just before the sled reaches the end of the track, an automatic pick-up device will lift off the front wall of the water chamber, and the vertical sheet of water will smash through the nozzle of the rocket.

The under-moderated, homogeneous uranium-zirconium hydride fuel used in *SNAP-2*, *-8*, and *-10A* reactors offers a high degree of inherent safety in an abortive spacecraft launch. The magnitude of possible excursions is limited, and at temperatures higher than 1,600°F, the hydrogen moderator chemically bound in the fuel is cooked out to halt the excursions and prevent excursions during a fire on the pad.

The conclusions were reported by D. J. Cockeram and R. L. Detterman of Atomics International at the Aerospace Nuclear Safety meeting in Albuquerque, N.M.

• **SNAP shakedown**—A series of tests will be conducted to measure *SNAP* reactor behavior during nuclear accidents, according to Lawrence I. Moss of Atomics International and T. R. Wilson of Phillips Petroleum Co. The *SNAP* Reactor Transient (SNAPTRAN) tests will begin this month and will use a number of reactors specially constructed with electrical heaters and other special devices to establish test conditions.

It is hoped that the SNAPTRAN series will yield more information about the mechanism by which hydrogen is transported in zirconium hydride at high temperature. The mechanism does not seem to have the temperature dependence ordinarily associated with diffusion. SNAPTRAN will be able to apply heating rates two orders of magnitude higher than the 7,500°C/sec. that is the highest achieved to date.

Reactor test machines in the series will be these:

—SNAPTRAN-2/10A-3, which will be a flight reactor core vessel without the beryllium reflectors. It will be immersed in water which will act as a reflector to produce a large reactivity input before the machine destroys itself.

—SNAPTRAN-2/10A-4, which will also be water-reflected, but will be tested to investigate steady-state operation in water.

—SNAPTRAN-8-5, which will evaluate *SNAP-8* behavior in any circumstances in which it might differ from that of *SNAP-2/10A*. ■

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- pulse doppler radars that measure range rate to 0.1 fps.
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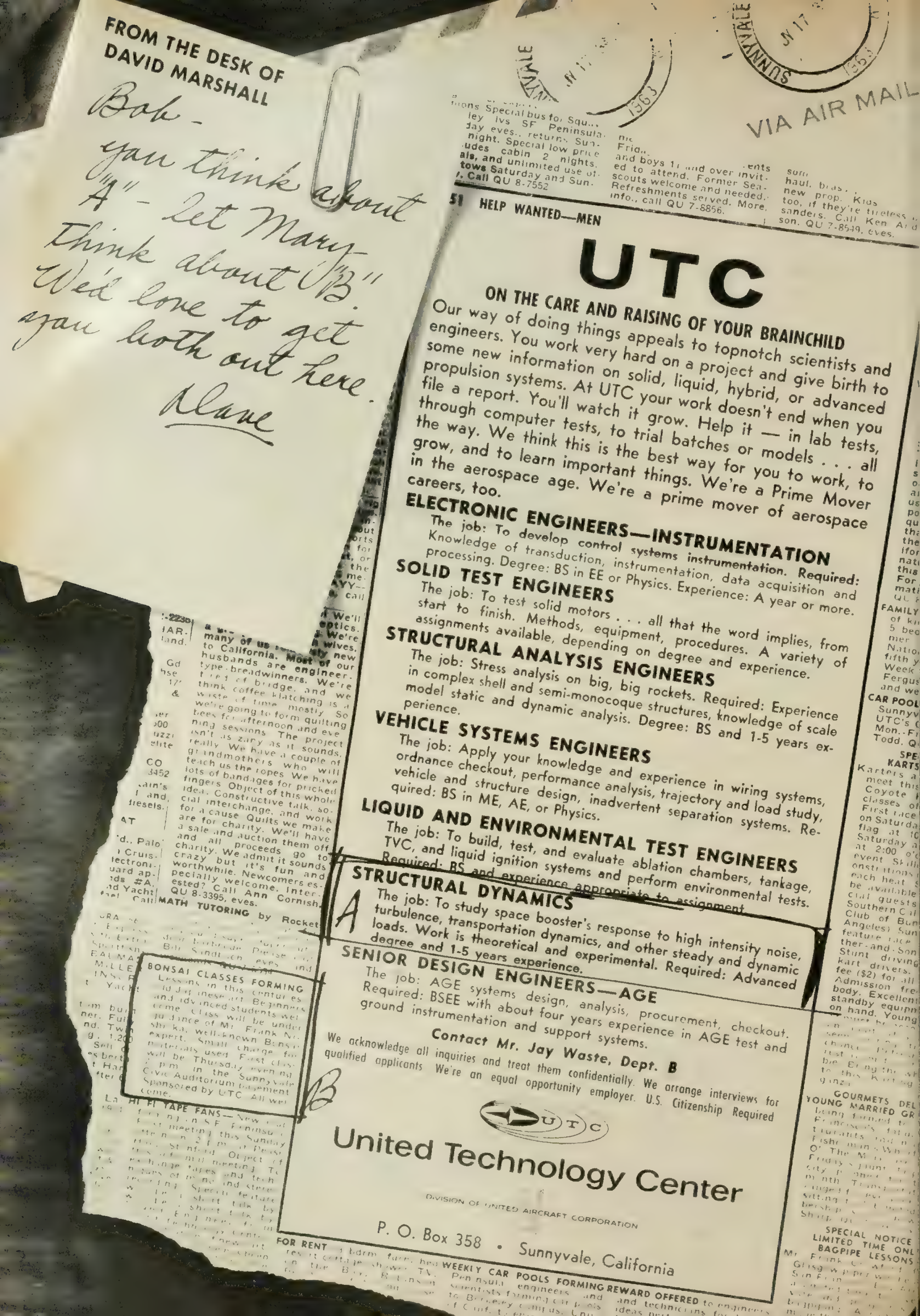

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The Industry Week

Mergers and Acquisitions

Solatron, Inc., Anaheim, Calif., formerly a subsidiary of Electro-Mechanical Research, Inc., Sarasota, Fla., has been made a division of that firm. It will continue under the same management as the Solatron Div. EMR specializes in telemetry, data-handling, data processing and computational equipment and systems for the missile/space industry. . . . *Auto Data, Inc., San Diego, Calif., manufacturer of digital voltmeters, has been merged with the Houston Instrument Corp., Bellaire, Tex. ADI was formerly a subsidiary of the Texas firm; it is now a division of that company. All manufacturing and operations will be conducted at the Texas facilities.* . . . Aerological Research, Inc., Long Branch, N.J., has acquired 51% of the common stock of Atlantic Semiconductor, Inc., Asbury Park, N.J., manufacturers of semiconductor components. Although each company will remain as individual corporations, they will increase cooperation, particularly in the areas of research and development. . . . *Atlantic Instruments & Electronics, Inc., Boston, Mass., has acquired controlling interest in Astromarine Products Corp., Melrose Park, Ill., which recently established a new laser and opti-electronic division. AIE specializes in the design and engineering of circuit miniaturization and packaging, servo actuators, electronic sensors and instruments. Parallel research, development and production of Astromarine products will be conducted in both the Boston and Melrose Park plants.*

New Firms and Divisions

Fischbach and Moore, Inc., Dallas, electrical contractors, have formed a new division with expanded capabilities in the systems field. The division, F&M Systems Co., was formed from the firm's Instrumentation Div. All personnel will continue in their positions. Acquisition of additional facilities is being negotiated. . . . *General Technology Corp., Torrance, Calif., has formed an operating division to handle vacuum and controlled atmosphere equipment. The new unit, Vacuum Products Div., will combine the activities of GTC's Royal Research Div. and Space Simulation Systems Group.* . . . International Resistance Co., Philadelphia, has established an Instrumentation & Systems Div. to design, manufacture and market electro-mechanical/electronic subsystems and associated equipment. The unit was formed by integrating the firm's Control Components Div. with its recently merged Frontier Electronics Div. and Plastic Products Div. . . . *Autonetics, a division of North American Aviation, Inc., has changed the name of its Computer and Data Systems Div. to Data Systems. The name is said to more fully describe the division's operational field, which includes development and production of advanced computer systems, flight control systems for missile/space use and command and control systems for defense use.* . . . Standard Products, Inc., Wichita, Kan., a subsidiary of Electronic Communications, Inc., St. Petersburg, Fla., has changed its name to Standard Precision, Inc. SPI designs and manufactures electronic and mechanical instruments and devices for the missile/space industry. . . . *Sperry Gyroscope Co., a division of Sperry Rand Corp., Great Neck, N.Y., has established an Information and Communications Div.*

Industry Facilities

Ground was broken last week for Lockheed-Georgia's Research Center facilities at Marietta, Ga. First units of the aerospace firm's new plant will be finished next year. Completion of the multibuilding complex is scheduled for late 1965. . . . *Dedication ceremonies were held recently for National Helium Corp.'s helium extraction plant at Liberal, Kan. NHC is jointly owned by Panhandle Eastern Pipe Line Co. and National Distillers. The plant, which went on stream in July, will produce a billion cubic feet of helium annually over a 20-year period.* . . . Armco Steel Corp., Middletown, Ohio, has announced plans to install a vacuum arc melting furnace at its Baltimore works for production of stainless steels and superalloys. . . . *Thermo-Resist, Inc., Fullerton, Calif., has relocated its main plant and office at 2430 Cypress Way in Fullerton. The expansion will allow TRI, manufacturers of high temperature adhesives, ablatives, sealants and thermal coatings, to introduce a line of metal-organic polymeric resins.* . . . International Telephone & Telegraph Corp., New York City, has announced plans to construct a $3,000,000 plant in West Palm Beach, Fla., to manufacture integrated circuits and other semiconductor devices. The plant will be under the management of ITT's Semi-Conductors, Inc. Completion of the one-story building is scheduled for February, 1964.

In The Courts

Burroughs Corp., Detroit, has filed a patent infringement suit in federal court in New York City against Amperex Electronic Corp., Hicksville, N.Y. Burroughs charges that Amperex has knowingly sold beam switching tubes and indicator tubes on which Burroughs owns U.S. patents, and seeks preliminary and permanent injunctions against the infringement. . . . *American Potash & Chemical Corp., Los Angeles, had brought suit against Atlantic Research Corp., Alexandria, Va., in the U.S. District Court in Alexandria for the return of assets of its former National Northern Div. or for $934,200 in damages. APCC transferred the assets of that division to ARC in June, 1961, in return for 29,000 shares of ARC stock. APCC says that Atlantic acknowledged in November, 1962, that the registration statement concerning these shares and filed by Atlantic in July, 1962, included untrue statements of material facts.*

contracts and procurements

AWARDS

AIR FORCE

$8,200,000—**Cutler-Hammer, Inc.**, Deer Park, N.Y., for work on a classified project.

$4,200,000—**Cutler-Hammer, Inc.**, Deer Park, N.Y., for engineering services on electronic reconnaissance equipment.

$3,745,000—**Thiokol Chemical Corp.**, Bristol, Pa., for qualification testing and production of motors for the *Genie* air-to-air missile.

$3,700,000—**Raytheon Co.**, Andover, Mass., for work on an experimental system to detect missile launchings.

$2,700,000—**American Bosch Arma Corp.**, Garden City, N.Y., for maintenance of *Atlas* ICBMs.

$1,900,000—**Marquardt Corp.**, Pomona, Calif., for *Atlas* missile trainers.

$1,200,000—**Electronic Associates, Inc.**, Long Branch, N.J., for service and maintenance of analog computer facility at Holloman AFB, N.M.

$220,191—**Space Technology Laboratories**, Redondo Beach, Calif., for support of the *Atlas E* and *F* missile targeting program.

$179,739—**North American Aviation, Inc., Rocketdyne Div.**, Canoga Park, Calif., for in-service engineering supporting *Atlas* and *Thor* propulsion systems.

$170,300—**Ewen-Knight Corp.**, East Natick, Mass., for study of radiometric characteristics of the atmosphere for sensing in space vehicle navigation.

ARMY

$17,780,509—**Eclipse Pioneer Div., Bendix Corp.**, Teterboro, N.J., for work on the *Pershing* ballistic missile system, including production of guidance and control systems for the missile, industrial engineering services, and research and development services.

$11,025,018—**Raytheon Co.**, Andover, Mass., for engineering services on the *Hawk* surface-to-air missile system.

$1,900,000—**General Motors Corp.**, Cleveland, for further work on the Sheridan vehicle for use in combination with the *Shillelagh* missile.

$1,898,709—**Western Electric Co.**, Winston-Salem, N.C., for work to be done in connection with the *Nike-Hercules* missile system.

$1,600,000—**Olin-Mathieson Chemical Corp.**, Charleston, Ind., for manufacture of propellant charges.

$1,384,808—**Raytheon Co.**, Ft. Bliss, Tex., for services and supplies required for the modification and checkout of assemblies, subassemblies and components for the *Hawk* missile system.

$1,800,000—**Systron-Donner Corp.**, Concord, Calif., for guidance system components for the *Lance* missile system.

$1,100,000—**General Dynamics Corp.**, Pomona, Calif., for continued development of the *Redeye* surface-to-surface guided missile.

$805,000—**Donaldson Co., Inc.**, Minneapolis, for research and development of air filtration systems in missile/space vehicles.

$297,000—**Chicago Aerial Industries, Inc.**, Barrington, Ill., for the development of manufacturing techniques and equipment for the mass production of fiber optic plates.

$85,741—**Thiokol Chemical Corp., Alpha Div.**, Huntsville, Ala., to refurbish one XM33E7 nozzle and two rocket motors and build one XM33E8 nozzle for Langley Research Center.

$37,306—**Honeywell Regulator Co.**, Hopkins, Minn., for study of skirt design modification on the XM398 missile.

Motorola, Inc., Solid State Systems Div., Phoenix, a 6-month contract for the development of microcircuits for linear communications functions. Goal is to design and fabricate thin-film versions of four micromodule units now being used in Radio Set AN/PRC-51 (undisclosed amount).

Emerson Electric Manufacturing Co., Spectral Technology and Applied Research Div., St. Louis, Mo., for study relative to an airborne, automatic target-stabilized tracker of a passive electro-optical nature (undisclosed amount).

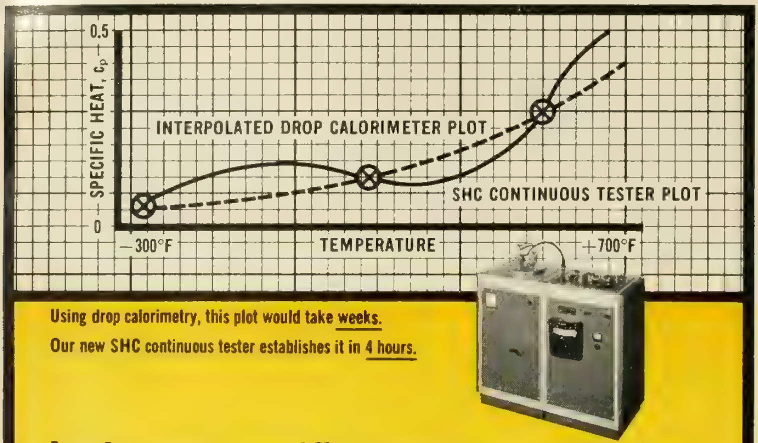
International Telephone & Telegraph Federal Laboratories, Nutley, N.J., for applied research in advanced space communication techniques to meet future military communication requirements (undisclosed amount).

NAVY

$14,200,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for production of Ship's Inertial Navigation Systems (SINS) for attack submarines, aircraft carriers and a missile tracking ship. A SINS will go aboard each of 21 vessels.

$11,100,000—**Hercules Powder Co.**, Rocket Center, W. Va., for research and development on solid propellants.

$9,900,000—**Bendix Corp.**, Mishawaka, Ind., for continued R&D on the *Typhon* missile.



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Circle No. 10 on Subscriber Service Card

$3,100,000—**Sperry Rand Corp.,** Long Island City, N.Y., for *Terrier* and *Tartar* missiles.

$2,300,000—**Avco Corp.,** Richmond Va., for arming and fuzing devices for the *Polaris* missile system.

$2,200,000—**Northrop Corp.,** Anaheim, Calif., for engineering services and support for the *Polaris* missile program.

$2,000,000—**Western Electric Co.,** Winston-Salem, N.C., for engineering services for the *Terrier, Tartar* and *Talos* missile programs.

$1,300,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for work on the *Polaris* missile program.

$200,000—**Informatics, Inc.,** Culver City, Calif., for systems design services for the Real Time Data Handling System of the Pacific Missile Range.

Global Associates, Inc., Oakland, Calif., for logistic support of the operation of Eniwetok and Kwajalein Atolls in the Pacific.

NASA

$4,400,000—**Aerojet-General Corp.,** Azusa, Calif., for an R&D program to obtain a *SNAP-8* nuclear electrical generating system with a minimum output of 35-kc power.

$3,600,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued work on liquid oxygen-hydrogen rocket engine.

$2,583,856—**Kaminer Construction Corp.,** Chamblee, Ga., for construction of facilities for testing J-2 rocket engines for the *Saturn V* booster at Marshall Space Flight Center.

$1,100,000—**Radio Corp. of America,** Van Nuys, Calif., for development and delivery of five display systems for the *Saturn* ground computer system.

INDUSTRY

$2,000,000—**Motorola, Inc., Military Electronics Div.,** Scottsdale, Ariz., from **North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for development and production of spaceborne data link equipment for the *Apollo* spacecraft.

$912,800—**Sperry Rand Corp., Univac Div.,** St. Paul, Minn., from **North American Aviation, Inc.,** Columbus, Ohio, for development of magnetic tape units.

$707,000—**Honeycomb Products, Inc.,** Miami, Fla., from **North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for honeycomb core material for the second stage of the *Saturn V* rocket.

$210,000—**Ramcor, Inc.,** Hicksville, N.Y., to produce microwave switches for **Jet Propulsion Laboratories,** Pasadena, Calif.

$170,000—**Lear-Siegler, Inc., Instrument Div.,** Grand Rapids, Mich., from **The Boeing Co.,** Seattle, for the design and development of a rate-of-climb indicator for the manned, winged spacecraft.

$112,000—**American Brake Shoe Co., Dynisco Div.,** Cambridge, Mass., from **The Boeing Co.,** Seattle, for electronic transducers for use in the *X-20* spacecraft.

$100,017—**Fairchild Stratos Corp., Stratos Div.,** Manhattan Beach, Calif., from the **Martin Co., Denver Div.,** Denver, for production of quick-disconnect coupling assemblies for the *Titan III* launch vehicle.

$100,000—**Veeder-Root, Inc.,** Hartford, Conn., from **The Boeing Co.,** Seattle, for an elapsed time indicator for use in the *X-20* spacecraft.

$100,000—**RdF Corp.,** Hudson, N.H., from **Martin Co., Denver Div.,** Denver, for development and manufacture of convective heat and thermal radiation transducers for use in the *Titan III* space launch system program.

INSIDE STORY
of a 150-joule laser

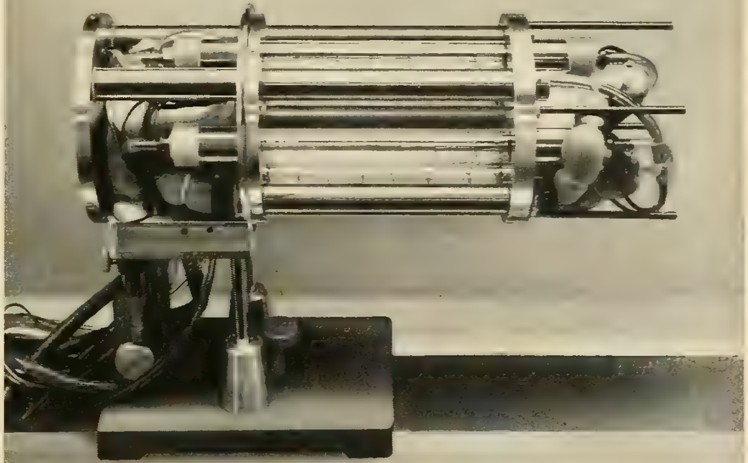
A powerful laser system with a 150-joule output is one of LSI Laser Systems Center's latest achievements in coherent light. In addition to this high energy capability, it can produce high peak power, or it can be operated at rates up to 20 firings per minute. This new unit was developed by a skilled technical staff to meet the needs of a very particular customer.

The Laser Systems Center meets the needs of *many* very particular customers. Our research and development activities have led to several important new coherent light products in addition to the 150-joule laser. A calorimeter with greatly improved accuracy, an ultra-high speed Q-switch, and Schlieren photography devices are among the new products that will soon be available as a result of Laser Systems Center research.

The LSI research capabilities that made these new products possible can serve you too. Why not write us to find out how we can assist you in taking advantage of a rapidly advancing laser technology?

The 150-joule LSI Laser, shown below with reflectors and cover removed, uses four water-cooled linear flashlamps in a clover-leaf elliptical cavity to achieve its high output.

...another product of LSI research



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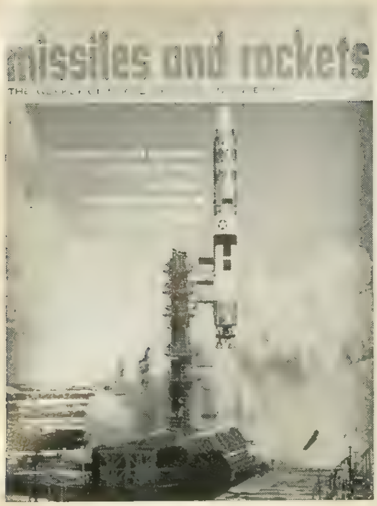

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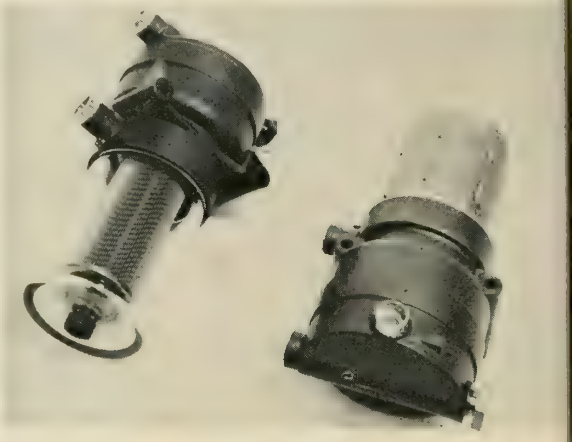
New Product of the Week:

Air-Oil Separator



Seaton-Wilson Manufacturing Co. has available the Model S-130 Separate-Aire, a filtering device designed to remove both free and entrained air from the fluid of a hydraulic system.

The unit is 7⅞ in. long and 3½ in. in diameter and weighs 30 lbs. It is designed for operation with an 8-gal. hydraulic system. Multiple units may be installed to fit larger systems.

In principle, the unit utilizes a built-in aspirator that produces a vacuum in a de-gassing chamber. Purged air accumulates on a filter and is collected in an upper cavity of the housing. Periodically, the air is vented through a dump valve. The number of de-gassing and dump cycles depends upon the volume of the system and the minimum volume of entrained air.

Circle No. 225 on Subscriber Service Card

Non-glare Microfilming

Stanpat Co. has available a non-glare formula developed to prevent microfilm "burn" on drafting details in reproduction.

The company says the formula eliminates "burn" because the drafting material used does not have the shiny surface that reflects light back to the microfilm camera. The formula is contained exclusively in all Stanpat sheets.

Circle No. 226 on Subscriber Service Card

Pneumatic Test Console

A multi-purpose pneumatic test console for testing and measuring aerospace components has been introduced by General Electric Co.'s Malta Test Station.

The unit can be used with most known gases. Its exhaust system permits recovery and re-use of gas, or venting into the atmosphere.

The console provides environmental conditioning, gas temperature control to 200°F and test specimen temperature control from −100 to 200°F.

The device can perform proof testing, flow rating, stroke termination testing and temperature controls testing. It also measures the rate of leakage and pneumatic response.

The system provides four regulated gas supplies. Three are functional and permit use of three different gases for an entire series of tests. The fourth employs helium to pressurize for mass spectrometer leakage measurements.

Circle No. 227 on Subscriber Service Card

Pulse Module

Deltime, Inc., has developed the Model CGM-16 solid-state module. The device produces random pattern serial pulse trains up to 16 bits long from a single input trigger at pulse repetition rates to 1 mc.

The model is designed for single or multiple pulse triggering of high power pulse generators. Pulse code selection is accomplished by the insertion of miniature jumpers into control jacks.

Up to 16 output pulses −6.6v in amplitude and 0.5 μsec in width can be obtained. Rise and fall times are less than 0.1 μsec. Input trigger requirements are nominally −6v amplitude, 0.3 μsec. width and rise and fall times less than 0.8 μsec. Power requirements are ±12v dc.

Circle No. 228 on Subscriber Service Card

Objective:
Constant acceleration of progress...in aerospace technology

The problems become continuously more complex and sophisticated. Their resolution is urgent.

The United States Air Force has designated the Air Force Systems Command as the single overall manager for the many steps involved in the acquisition of aerospace systems—including research, advanced technology, development, test, procurement, contract management and missile site activation.

To provide essential direction and support to this broad spectrum of challenging programs, AFSC maintains its own in-house capability through a number of divisions, centers and contract management regions located throughout the nation. The responsibilities and missions assigned to these highly specialized organizations embrace most of the basic scientific and engineering disciplines and their interrelations plus procurement, contract management and related support activity.

The civilian-military staff of AFSC makes direct contributions to some of this nation's most complex and vital aerospace programs. This provides an opportunity for the scientists and engineers of AFSC to work across a broad spectrum of technical areas. Many of the basic ideas, techniques, and concepts on which future Air Force systems are based come from AFSC's own staff.

AFSC employment benefits include patent protection for inventions, opportunity for advanced study, authorship credit on scientific papers, honorary, academic and cash awards, promotion based on merit, health and retirement benefit programs, low cost life insurance, paid vacations and sick leave, plus all the benefits of civil service.

AIR FORCE SYSTEMS COMMAND
has immediate openings for engineers and scientists in these areas.

ELECTRONIC ENGINEERS (NAVIGATION)—To propose new theories of design and operation of advanced inertial navigation systems. Must have a thorough understanding of the state-of-the-art and its patterns of development.

RANGE INSTRUMENTATION ENGINEERS—To evaluate Range Contractor instrumentation proposals designed to meet test requirements by using telemetering means which include HF, VHF, UHF transmission and receiving equipment, complex antenna systems, recording systems.

MECHANICAL ENGINEER—Duties will involve studies in technical integrity and functional operation of all airborne and ground mechanical systems, subsystems and equipment of advanced missile systems.

AEROSPACE ENGINEERS—To assess and analyze foreign competency in such areas as aero-research and development, power plant and propulsion development, weapon systems and warfare systems.

ELECTRONICS ENGINEER (RADAR)—Strong background in development, fabrication, installation, maintenance and experimental operation of large radar sites. Should possess ability to recognize deficiencies and incompatibilities in plans.

PHYSICIST (OPTICS)—Exercise management direction of Range Contractor's function in developing infrared instrumentation plans to meet missile test requirements. Initiate and evaluate contractor proposals in area of infrared instrumentation systems. Bachelor's degree in Physics with strong optics option required, plus 4 years' professional experience including planning and engineering of complete infrared systems.

Scientists and engineers interested in joining the staff of AFSC are invited to send their resume or Application for Federal Employment (SF-57) with geographical preference and salary requirement
to:

United States Air Force
AFSC-AFLC Joint Professional Placement Office
527 Madison Avenue, Dept.MR-10, New York 22, N. Y.
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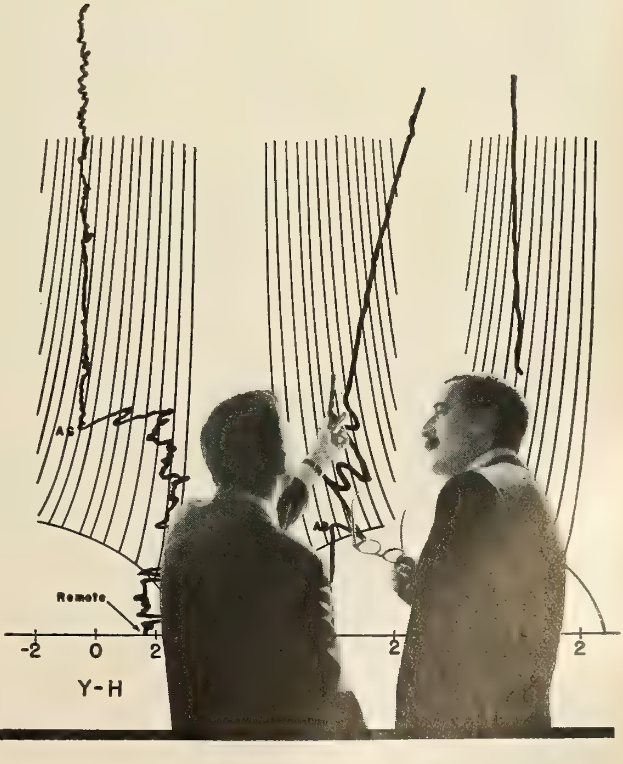


Circle No. 11 on Subscriber Service Card

M/R

missiles and rocket

Advanced Research, Technology and Development

Issue Date
November 25
1963

Advertising Closes
November 11
1963

Projects Gemini and Apollo are well under way. The National Aeronautics and Space Administration is currently planning future projects like the orbiting space station, lunar base, manned Mars expedition, unmanned exploration of the Sun and the distant planets, and detailed investigation of Earth's environment.

M/R's Third Annual National Aeronautics and Space Administration issue will be a 100-page report covering advanced research, technology and development requirements for these programs.

hird annual NASA issue

This issue will include:

1. Advanced Research and Technology

Spacecraft Structures ☐ Propulsion ☐ Nuclear Systems ☐ Electronics ☐ Biotechnology and Environmental Systems

2. Funding Requirements and Procurement Policy

NASA's in-house apportionment of the Fiscal Year 1964 Budget ☐ Effects of Congressional cuts in the budget ☐ Report on Fiscal Year 1965 Budget ☐ Budget Projection through 1975

3. Advanced Development Programs

Manned Spaceflight ☐ Unmanned Interplanetary Spacecraft ☐ Scientific Satellites ☐ Commercial Application Satellites ☐ Launch Vehicles after Saturn ☐ International Programs

4. NASA Field Centers

New facilities and equipment required at each installation by the advanced spacecraft and launch vehicles.

5. Directory of Key NASA Officials

Name ☐ Job Title ☐ Room and Telephone Numbers

5,000 Bonus Circulation to NASA Officials

Total NASA Circulation 6,500.

43,170 Regular ABC paid circulation.

48,170 Total Effective Audience

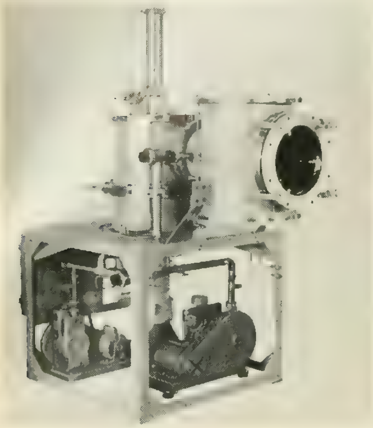
NASA will award many of the study and hardware development contracts for these projects by mid-1964. Advertise your products and capabilities in M/R's Third Annual NASA issue to reach your audience at this critical decision time.

Advertising Closes November [illegible]

Vacuum Evaporator

General Vacuum Corp. is marketing the Type 1444 evaporator, featuring a high-speed, ultra-high vacuum pumping system.

Pressures of 5×10^{-7} torr are attained in 15 minutes, and the ultimate is below 2×10^{-8} torr. The reservoir-type trap is liquid-nitrogen cooled; has complete optical density and an anti-migration shield.



Accessories include plain or water-cooled chamber, temperature-controlled shrouds, new seals for rotary motion and equipment for glow discharge, evaporation or sputtering and electron-beam heating.

Circle No. 229 on Subscriber Service Card

Teflon Heating Cable

Hitemp Wires Co. has available a Teflon insulated heating cable. Rated for service up to 500°F, the cable comes in longitudinal or spiral systems.

It may be bent around 1½ to 2 times its own diameter and maintains its trained form. Chemically inert, the cable is not damaged by chemical and corrosive atmospheres.

Circle No. 230 on Subscriber Service Card

Power Amplifiers

Burr-Brown Research Corp. has developed a pair of solid-state power amplifiers with an output circuit designed to draw minimum idle current from external power supplies.

The Model 1633 is a single-ended, non-inverting amplifier designed to deliver up to ±10v at 500 ma. Input impedance is greater than one megohm; output impedance is less than 0.1 ohm. Response is ±0.1 db from dc to 5k cps and ±3 db to 100k cps. Stability is better than 0.5% of full scale output.

The Model 1635 is a differential input/output amplifier designed to deliver 60-v peak-to-peak at 500 ma. Input impedance is 20k ohms; output impedance is less than 0.3 ohm; Response is ±0.5 db from dc to 10k cps and ±3 to 50k cps. The unit operates on a ±20v supply.

Circle No. 231 on Subscriber Service Card

Solid-State Transmitter

Aircraft Armaments, Inc., is marketing the Model 5690 PPM telemetry transmitter. The solid-state unit provides a 30-watt peak pulse output at 227 to 246 mc.

The device is crystal controlled with a frequency stability of 0.01% under all environmental conditions. Input voltage ranges from 24 to 40v dc with constant RF output. At 28v dc, the unit requires 250 ma.

Pulse intervals are less than 70 db down from pulse; pulse width is 3.5 μsec. Rise time is 0.3 μsec; fall time is 0.15 μsec. Operational temperatures are −20° to 75° C.

Circle No. 232 on Subscriber Service Card

Linear Actuator

Aircraft and Missiles Div. of Barber-Colman Co. has developed an electromechanical linear actuator available in three standard versions for ac and dc operation.

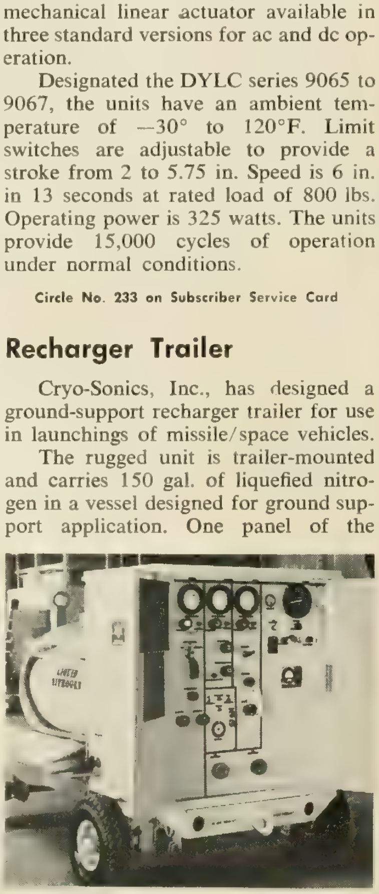
Designated the DYLC series 9065 to 9067, the units have an ambient temperature of −30° to 120°F. Limit switches are adjustable to provide a stroke from 2 to 5.75 in. Speed is 6 in. in 13 seconds at rated load of 800 lbs. Operating power is 325 watts. The units provide 15,000 cycles of operation under normal conditions.

Circle No. 233 on Subscriber Service Card

Recharger Trailer

Cryo-Sonics, Inc., has designed a ground-support recharger trailer for use in launchings of missile/space vehicles.

The rugged unit is trailer-mounted and carries 150 gal. of liquefied nitrogen in a vessel designed for ground support application. One panel of the vehicle is a precision control board with accessible controls and accessories for applying variable discharge pressures of the gas at required constant flow rates.



The unit provides high pressure gas at ambient temperature 1,500 SCFH at 5,000 psig. The entire unit measures 105 x 60 x 72 in.

Circle No. 234 on Subscriber Service Card

Unregulated Power Modules

Valor Instruments, Inc., has developed two series of unregulated ac-to-dc power modules. The units provide any output voltage from 7 to 80v dc with loads from 4 to 0.25 amperes. Low ripple is achieved by capacitive filtering.

Input voltage is 115v, 50 to 400 cps. Operating temperatures range from −20° to 60°C. Isolation is 100 megohms dc.

Circle No. 235 on Subscriber Service Card

Miniaturized Valve

Circle Seal Products Co. has available a miniaturized stainless steel shutoff valve. Designated the 9400 series, the unit is leakproof and provides metering characteristics with a 0.156-in.-dia. orifice, permitting an unusually high flow rate.

CIRCLE
SEAL

The valve permits opening and closing against pressures in either direction with minimum torque. Normal operating pressure is 2,200 psi, but the device is operational at higher pressures. Temperature range of operation is −65° to 350°F. The valve efficiently handles air, GN_2, He, oil and other materials.

Circle No. 236 on Subscriber Service Card

DC/DC Power Converter

Astronetic Research, Inc., has available a dc/dc power converter, the Model ARI 377, with an output of 75 to 140 watts at high efficiency. The unit conforms to all radio and audio frequency interference requirements of MIL-I-6181D.

Efficiency of the device exceeds 75% over the input range of 25 to 29v dc. Output power is ±15v dc at 2.5 amps. Regulation is ±0.5% for all line and temperature variations and load conditions from ½ to full load.

Operating temperature is —20° to 100°C. Vibration range is 0.08 in. at 10 cps to 0.001 in. at 500 cps. Shock is 15g, 11 ms. The device meets MIL-E-5272C specifications.

Circle No. 237 on Subscriber Service Card

Micropulser

The Micropulser, a high current pulse generator, is being marketed by Rocket Research Corp.

The solid-state switching device converts dc power to square wave pulses of high amperage with variable pulse width and variable frequency. Current up to 10 amperes is delivered at 6 to 100v. Pulse width is variable from 0.1 milliseconds to 10 seconds and frequency varies from 0.1 to 10,000 pulses per second.

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An automatic pressure calibration system that will create or measure gage absolute and differential pressures from 0 to 15,000 psi with an accuracy of ±0.04% has been developed by Ruska Instrument Corp.

Reference pressures are established by primary pressure standards. Readout may be visual, punched tape, punched card or printer. The system is available with temperature and shock chambers for evaluation of pressure devices.

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Table Model ILD Machine

A table model machine for the determination of indentation load deflection (ILD) values of urethane and other flexible foams with an accuracy of ±1.75 ILD units has been developed by Southern Machine Products, Inc.

Completely manually operated, the machine requires no sample height or deflection calculations to obtain 25, 50, 65 or 75% ILD values.

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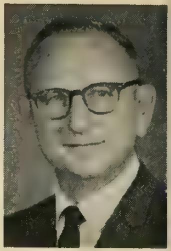

STEPHENS

James W. Kelly: Named manager of Communications Planning for Pan American World Airway's Guided Missile Range Division. He formerly was an Air Force colonel and served as chief of the Communications and Support Division of the AFMTC Range Program office.

Herschel D. Sterling: Joined the staff of Ortronix, Inc., Orlando, Fla., as engineering operations manager.

Col. James Bain, Jr.: Named chief of systems engineering in the *Mauler* project office, Redstone Arsenal.

John M. Ruffner: Named director of marketing for Republic Industrial Corp., New York City.

Samuel E. Cooper: Appointed engineering representative and ordnance specialist for Consolidated Systems Corp., Monrovia, Calif.

Ralph F. Carlson: Appointed vice president in charge of the newly formed Casting Potentials Div. at Alloy Engineering & Casting Co., Champaign, Ill.

Richard B. Laver: Appointed controller at Space-General Corp., El Monte, Calif. **John E. Wagner** named patent attorney. **Charles W. Hodges** named district manager, northwest central states regional offices, Dayton, Ohio and **Vernon L. Smith** appointed manager of the Subcontracting Dept.

John Hanway: Promoted to director-administration of International Telephone and Telegraph Corp., New York City.

Col. John F. Stephens (USA Ret.): Appointed chief engineer of research and development at Sperry Utah Co., Salt Lake City.

Clifford Warner: Named manager of the southwestern district sales office of Eitel-McCullough, Inc., San Carlos, Calif.

W. Stratton Anderson, Jr.: Named a vice president of General Telephone & Electronics International Inc. and GT&E Service Corp., Washington, D. C.

Col. Lawrence B. Ocamb (USAF Ret.): Named director of the Avco Corp.'s Management Analysis Group, New York City.

Ray Bogert: Appointed eastern regional sales manager for Mallory Capacitor Co., Indianapolis, Ind. **William Markley** named midwest regional sales manager and **Dan F. Mischler** appointed western regional sales manager.

Dr. James K. Tyson: Promoted to director of the Operations Research and Mathematical Sciences Div. at the Center for Naval Analyses, Washington, D.C. **William H. Meckling** named director of the Naval Warfare Analysis Group.

Roger H. Morley: Named president of the Parker-Kalon Div. of General American Transportation Corp., Clifton, N.J.

Dr. Robert N. Grosse: Appointed chief of the Economics and Costing Div. of the Research Analysis Corp., Bethesda, Md.

Dr. Reno C. King: Named assistant chief mechanical engineer of Gibbs & Hill, Inc., New York City.

Henry C. Nickel: Appointed general manager of Allis-Chalmers' Atomic Energy Div., Bethesda, Md.

William R. Monroe: Elected vice president of engineering at Astropower, Inc., Newport Beach, Calif.

Carl Dekker: Appointed staff assistant to the superintendent of scientific instrument manufacturing at Bausch & Lomb Inc., Rochester, N.Y.

Jack R. Hietanen: Appointed research scientist in the Research and Development Laboratory of Erie Technological Products, Inc., Erie, Pa.

George Klotz: Appointed regional manager and field engineer for the northwestern United States for McCormick Selph Associates, Santa Clara, Calif.

Kenneth H. Kirgin: Appointed foundry industry manager in the Nickel Sales Dept. of the International Nickel Co., Inc., New York City.

Frank J. Warzak: Appointed general manager of Varo, Inc.'s Optical Div., Chicago. **Robert P. Voras** appointed chief engineer.

William H. Habblett: Special assistant to the president and chairman of Northrop Corp., Beverly Hills, Calif., appointed corporate director of special events.

—when and where—

OCTOBER

Materials Handling Conference, sponsored by ASME, AIEE and IRE, Chamberlain Hotel, Newport News, Va., Oct. 14-15.

Course on Space Power Systems, sponsored by George Washington University's College of General Studies, Airlie Center, Warrenton, Va., Oct. 14-15.

Advanced Purchasing and Subcontract Management Course, sponsored by the National Defense Education Institute, Charter House Hotel, Cambridge, Mass., Oct. 14-18.

Users of Automatic Information Display Equipment Annual Meeting, Carillon Hotel, Miami Beach, Fla., Oct. 15-17.

Eight Symposium on Ballistic Missile and Space Technology, sponsored by AF Space Systems Div., and Aerospace Corp., Naval Training Center, San Diego, Calif., Oct. 15-18.

Second Annual Technical Colloquium, Society of American Value Engineers, Airport Marina Hotel, Los Angeles, Oct. 16.

AIAA/CASI RAES Ninth Anglo-American Conference, Massachusetts Institute of Technology, Cambridge, Oct. 16-18.

American Vacuum Society, National Symposium on Vacuum Technology, Statler-Hilton Hotel, Boston, Oct. 16-18.

Fourth Annual One-Day Technical Symposium on Information Processing, University of Maryland, College Park, Oct. 17.

Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, IEEE, Emerson Hotel, Baltimore, Oct. 21-23.

American Society for Metals, Annual Meetting and National Metals/Materials Show and Exposition, Public Auditorium, Cleveland, Oct. 21-25.

23rd National Convention, Society for Nondestructive Testing, Pick-Carter Hotel, Cleveland, Oct. 21-25.

Ninth Conference on the Design of Experiments in Army Research, Development and Testing, Redstone Arsenal, Huntsville, Ala., Oct. 23-25 (by invitation only).

Human Factors Society Annual Meeting, Ricky's Hyatt House, Palo Alto, Calif., Oct. 23-25.

Optical Society of America Annual Meeting, Sherman House, Chicago, Oct. 23-25.

National Electronics Conference, McCormick Place, Chicago, Oct. 28-30.

13th Annual Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 28-29.

Western States Section of the Combustion Institute Fall Meeting, University of Southern California, Los Angeles, Oct. 28-29.

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION REQUIRED BY THE ACT OF OCTOBER 23, 1962; SECTION 4369, TITLE 39, UNITED STATES CODE.

1. Date of filling: Sept. 23, 1963.

2. Title of publication: Missiles and Rockets.

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6. Names and Addresses of Publisher, Editor, and Managing Editor: Publisher, James W. Claar, 607 Waterway Drive, Falls Church, Va.; Editor, William J. Coughlin, 1330 New Hampshire Avenue, NW, Washington, D.C.; Managing Editor, D. Reed Bundy, 534 Sixth Street, SE, Washington, D.C.

7. The owner is: American Aviation Publications, Inc., 1001 Vermont Avenue, NW, Washington, D.C., 20005. Stockholders owning 1% or more of total amount of stock: Wayne W. Parrish, 2445 Wyoming Avenue, NW, Washington, D.C.; Eric Bramley, 100 Morningside Drive, Alexandria, Va.; Fred S. Hunter, 6707 Colbath Avenue, Van Nuys, Calif.; E. J. Stackpole, Harrisburg, Pa.; A. H. Stackpole, Harrisburg, Pa.

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9. Paragraphs 7 and 8 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner. Names and addresses of individuals who are stockholders of a corporation which itself is a stockholder or holder of bonds, mortgages or other securities of the publishing corporation have been included in paragraphs 7 and 8 when the interests of such individuals are equivalent to 1% or more of the total amount of the stock or securities of the publishing corporation.

10. (First figure in each category refers to average no. of copies each issue during preceding 12 months; second figure refers to single issue nearest to filing date). A. Total no. copies printed (net press run): 44,143; 45,526 (9/23/63). B. Paid circulation: 1. To term subscribers by mail, carrier delivery or by other means: 42,288; 43,314. 2. Sales through agents, news dealers, or otherwise: None (no newsstand sales). C. Free distribution (including samples) by mail, carrier delivery, or by other means: 1,855; 2,212. D. Total no. of copies distributed (sum of B.1, B.2 and C): 44,143; 45,526. I certify that the statements made by me above are correct and complete.

JAMES W. CLAAR
(Signature of Publisher)

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A Lunar Proposal

AS IT STANDS, President Kennedy's proposal before the United Nations of a joint Soviet-American expedition to the Moon is unlikely to be implemented because of its limitations from both the U.S. and Soviet viewpoints. Among the reasons:

—The U.S. manned lunar program, Project *Apollo,* is too far advanced in design and engineering to make possible any joint technical effort on development of hardware. The Soviet lunar project is believed to be in an equally advanced stage.

—Due to the association of both projects with boosters possessing military capabilities, military security freezes the two nations in a position where cooperation involving hardware is undesirable because of national interest.

—Any implementation of such a joint project will tend to lessen the competitive drive and national support of the existing lunar programs, with probable reduction of funding—as evidenced by the most recent Congressional budget cuts which followed the President's suggestion of an international effort to land man on the Moon.

—The mutual trust necessary to such a joint program does not exist. Too much national prestige already has been staked on the lunar race for either nation to abandon it without fear that the other is secretly continuing the effort to be first.

There is, however, an area where cooperation on a lunar project by the Soviet Union and the United States appears not only practical but desirable. We believe the U.S. proposal should be extended immediately to include this area.

We propose that the Soviet Union and the United States immediately initiate a joint program for establishment of a scientific base on the Moon following the early exploratory lunar flights.

Without question, establishment of such a lunar base is the next logical step in man's conquest of space. Neither nation intends merely to touch foot on the Moon and then abandon interest in it.

But equally without question is the fact that a lunar base is a project which will require financing of a level to dwarf even Project *Apollo.* One estimate by a national space official places the cost of establishing and initially maintaining such a base at $100 billion dollars—compared to the estimate of $20 to $30 billion for the *Apollo* program.

An international approach to a project of such magnitude obviously would be desirable. A joint Soviet-American project team could begin immediate study, without compromise of national security, in such areas as determination of the most desirable base site, the life-support system, the astronomical, geophysical, biological and other scientific studies to be undertaken, size of the lunar cadre, common communications frequencies, engineering of the base itself and requirements for logistic support. There could be appropriate division of the scientific, engineering and logistics tasks to minimize interface problems.

We believe there are these advantages to such a proposal:

1. Cost-sharing on such a project would bring the financing to a more attractive level, to ensure earlier initiation of a manned lunar base program.

2. Research and development on the lunar base can be initiated as a joint program, whereas *Apollo* and the Soviet lunar landing program are too far advanced for such cooperation.

3. Firm establishment at this time of the logical follow-on program will place *Apollo,* as well as the Soviet project, in proper perspective as a means for further scientific achievement rather than as an end in itself. The lunar base project thus would enhance the *Apollo* program, rather than detract from it as the proposal for a joint landing expedition has done.

4. The race to place the first manned expedition on the Moon—which is a healthy international competition and one to which the Administration is committed—can continue on a national basis, not only benefiting the science and technology of both countries but assuring earlier discovery of the knowledge needed to erect a Moon base. The lunar base proposal therefore encourages rather than discourages continuation of *Apollo* at its present level of effort and funding.

5. Following the early exploratory flights, the logistics flights to build and maintain the lunar base and to ferry personnel to and from the Moon can continue to be made by Soviet or American spacecraft from purely national launch sites. Nor is any mating of space hardware, which could compromise security, involved. This eliminates a major stumbling block to Soviet-American cooperation.

Ample precedence for such international scientific cooperation exists in the Antarctic Research Program, being carried out cooperatively by the United States and the Soviet Union, together with other nations. During the past Antarctic summer season, for example, an American oceanographer was assigned as exchange scientist aboard the USSR supply ship Ob, carrying out measurements of the effective radiation temperature of surface waters in the coastal regions between the Soviet Mirny and Novolazrevskaya stations.

The joint lunar base program can be initiated immediately, further contributing to reduction of international tension and setting the precedent for later planetary exploration.

WE PROPOSE that the United States and the Soviet Union reach agreement on this program and that each set up a lunar base team of scientists and engineers to meet jointly on the project at the earliest practical date. We believe the program initially should be a Soviet-American effort with scientists of other nations brought in later for establishment of what could become a truly international scientific lunar base.

We urge Congress and the Administration to give this proposal the fullest and most serious consideration.

William J. Coughlin

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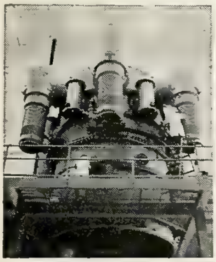

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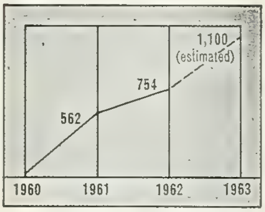

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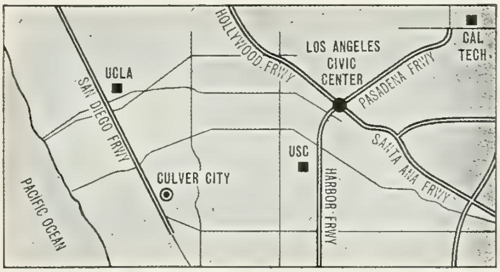

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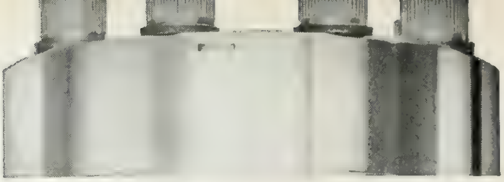

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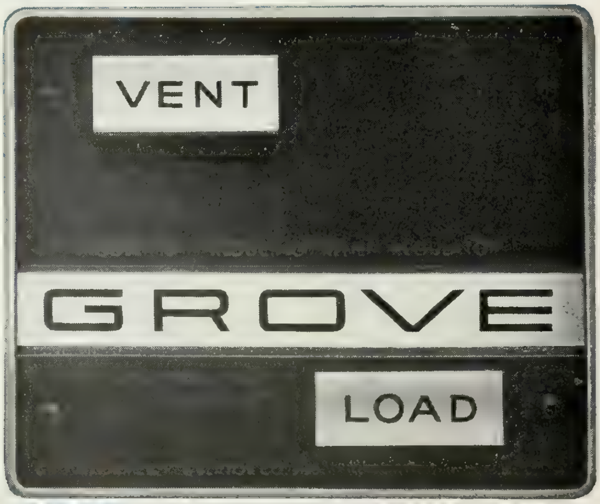

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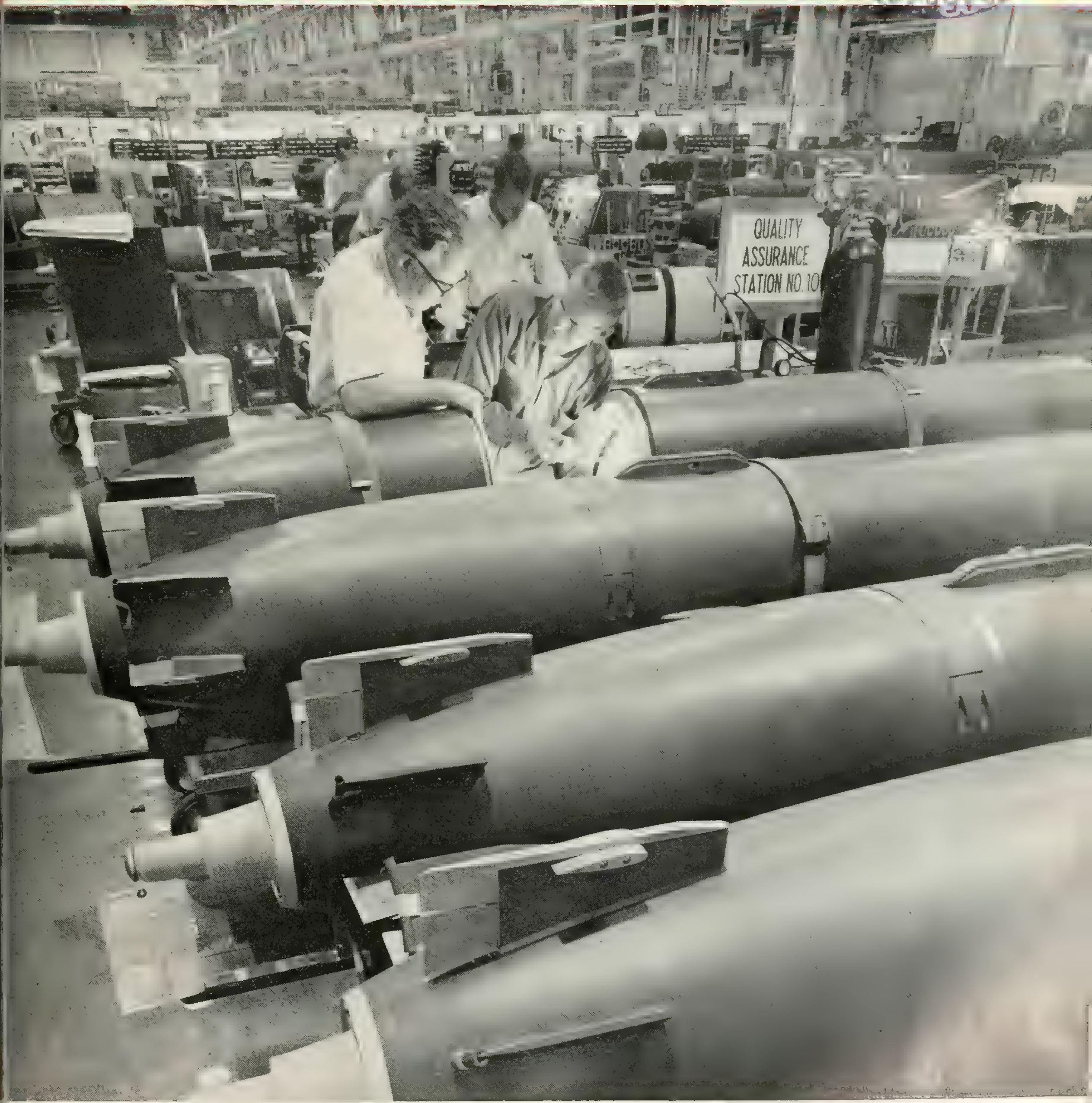
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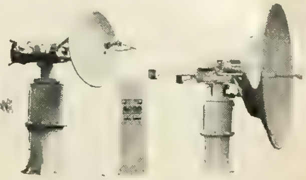

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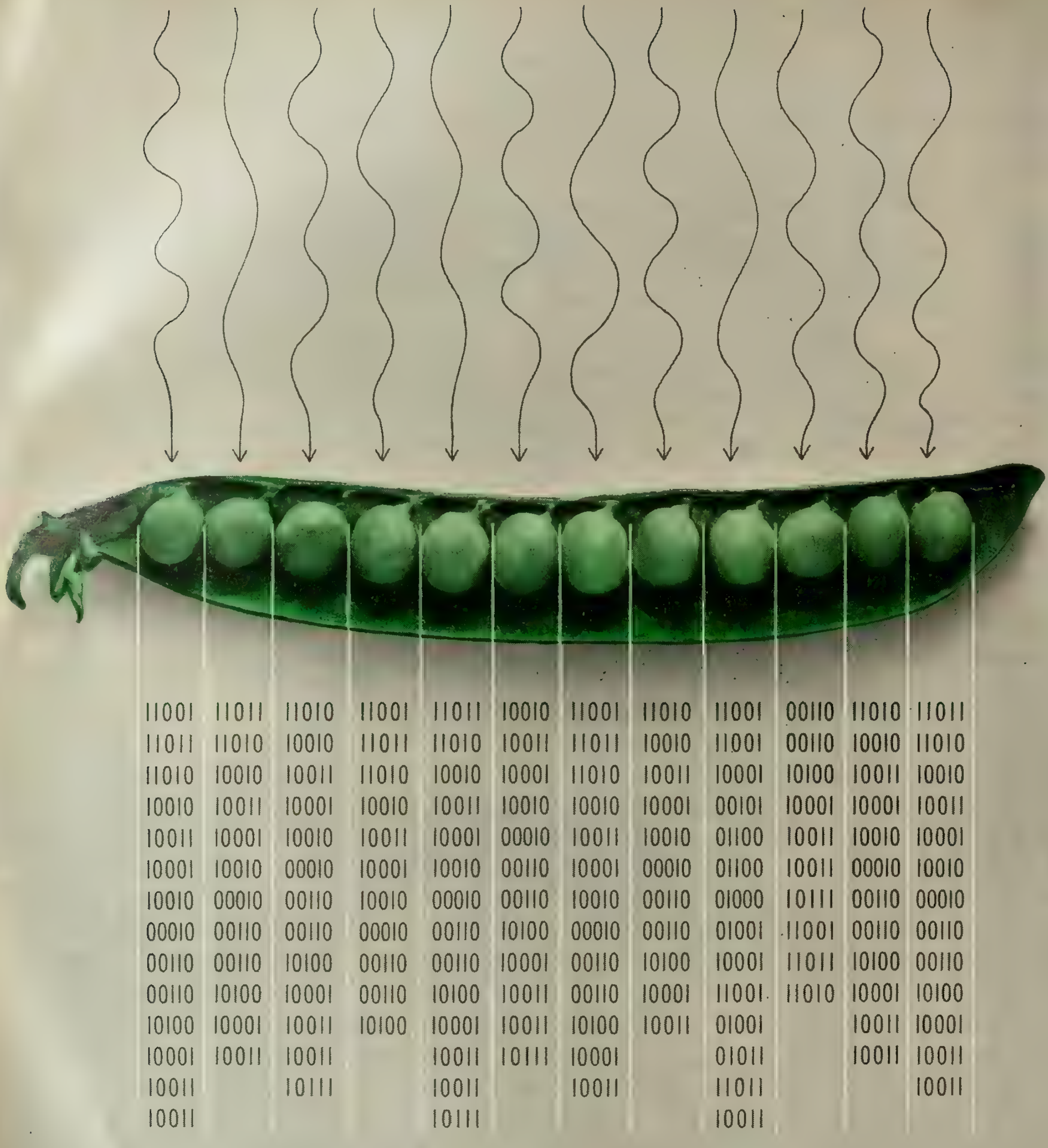
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 17 October 21, 1963

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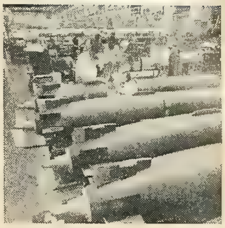

Final assembly of ASTOR Mk 45 wire-guided antisubmarine torpedoes is shown for the first time at Westinghouse Electric Corp.'s Baltimore facility. ASTOR is expected to be deployed soon on Navy's hunter-killer submarines. See p. 16.

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TRW Space Technology Laboratories is building electric power systems using electrochemical, photovoltaic and nuclear techniques. They are being used on America's major space programs, including OGO, Air Force 823 Program and Mariner. Engineers and scientists interested in energy conversion technology, transistor circuit design, electrochemistry and power system engineering should contact STL Professional Placement, One Space Park, Redondo Beach, Calif. Dept. 200. TRW is an equal opportunity employer.

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letters

The Reasons Why

To the Editor:

Your Sept. 30 editorial on "The Reasons Why" dealt with a critique of our President's question, "Why, therefore, should man's first flight to the Moon be a matter of national competition?" The tone of your "reasons why" then suggested that the question was one of continuing or abandoning the project.

Although I do not question your motivation, it seems to me that your desire to make a point was tainted by the interpretation you gave to the facts. You were so careful not to take Mr. Khrushchev's statement that "we will bury you" out of context, yet you proceeded to do exactly that with Mr. Kennedy's question. If you will examine it again, the key word is not "why" but "first." I do not believe our Administration is naive enough to even consider shelving our space efforts. They do, however, assume a very realistic attitude towards our capability to achieve a "first," as well as its practicality.

When all these efforts become history, I'm sure that the few months separating the individual achievements of both the Soviet Union and the United States will be completely overshadowed by their impact on humanity, and specific names and dates will be of academic interest, at best.

Although editorials are intrinsically opinionated, I don't think an issue can be effectively presented if the facts themselves lack objectivity by being used out of context, or analyzed with tunnel vision.

Robert J. Temes
Mt. View, Calif.

Lunar Probes

To the Editor:

Re H. Alfred Roloff's Sept. 30 letter on U.S. lunar probe attempts. It was a complete and factual presentation and one that I disagree with on just one point: the *Atlas-Able* launch on Nov. 26, 1959, exploded after 45 seconds of flight. I believe the failure occurred when the shroud about the third stage and payload came off at 45 seconds. The resultant atmospheric buffeting caused loss of telemetry and second-stage firing. The *Atlas* apparently flew through its sequence successfully.

Sp/4 Arthur W. LeBrun
Ft. Bragg, N.C.

Newton Revisited/Revised

To the Editor:

As one who was at the same college as the great Newton (though admittedly not at the same time), I was somewhat surprised by the definition of angular momentum attributed to the National Research Council (M/R, Oct. 14, p. 6).

Let us consider further the NRC example and suppose the particle to be constrained in its constant-speed circular motion by a weightless string. If this string is slowly winched-in until the radius is halved and then cut, the particle will, according to the NRC definition, fly off tangentially at the same veolcity it would have had if the string had been cut prior to winching-in.

The kinetic energy of the particle measured immediately after string-cutting is therefore the same at both radii considered, and hence we are left with the difficulty of finding out what has become of the work done during winching-in. This problem does not arise when the "unrevised" physics-book definition of angular momentum is applied, since the work done is completely accounted for by the increased kinetic energy of the particle.

R. W. Hogg
Washington, D.C.

Variety Is the Spice

To the Editor:

I think you owe it to your readers to notify them of the change in subject material of your magazine from aerospace to humor. After reading the letters to the editor in your Oct. 7 issue, I know your intent is to compete with *The New Yorker, Esquire, Playboy* and other similar humorous-type magazines. Are these letters really representative of the mail you get, or shall we now call your magazine the *John Birch Journal?*

J. M. Hally
Sunnyvale, Calif.

They were representative at that particular time, not necessarily representative earlier or later.—Ed.

Anderton Joins M/R As Contributing Editor

DAVID A. ANDERTON, an independent technical consultant to the aerospace industry, has been appointed a Contributing Editor of MISSILES AND ROCKETS.

Anderton has achieved an outstanding reputation for the accuracy and clarity of his technical writing during 13 years in the aerospace field.

Before starting his own business, Dave was Technical Editor of *Aviation Week & Space Technology*. Consulting will continue to be his primary work, but M/R readers may look forward to his technical articles on a regular and exclusive basis.

Prior to joining *Aviation Week*, Anderton, an engineering graduate of Rensselaer Polytechnic Institute, worked on aircraft and missile projects at Grumman Aircraft, Columbia Aircraft, Fairchild Engine and Airplane Corp. and General Electric Co.

STL
NEW
PROPULSION
OPPORTUNITIES
In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

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The Countdown

WASHINGTON

Agreement Is Signed on Manned Space Station

NASA and the Defense Dept. have signed an agreement to insure that the manned space station project is a national program. The pact calls for the Aeronautics and Astronautics Board to coordinate all study contracts for what is now termed a *Manned Orbiting Research and Development System (MORDS)*. The two agencies will lay out project specifications and make a recommendation to the President as to which agency should direct the program. When and if the project receives Presidential approval, the two agencies will establish a joint board similar to the current *Gemini* board to lay out experiments to be included in the program.

NASA Awards Nova Contract to Martin Co.

NASA is negotiating details of the follow-on study contract for the *Nova* launch vehicle with the Martin Co. The new study will wrap up Class I and II of the study program which covers very-high-thrust liquid or solid propulsion systems within the current state of the art. Contract will be worth about $1 million to Martin-Baltimore, which was competing with General Dynamics/Astronautics during the preliminary study phase. *Nova* is intended to lift a payload two to three times that of the *Saturn V*.

Further Launch Slippages Are Revealed

Launch slippages continue to plague NASA programs. Latest include delay of the Project *Fire* re-entry test and the *Nimbus* weather satellite launch until next spring.

Wiesner Questions Soviet Lunar Program

Presidential Science Advisor Dr. Jerome Wiesner still questions whether the Soviets have a lunar-landing program. He notes that they have said a great deal about it in public, but adds, "The remarks they make in private make you wonder." Wiesner was not consulted about the President's proposal for a joint lunar program—he was on vacation.

Senate Fight Expected on Lunar Ban

The ban against a joint U.S.-Soviet lunar program which the House tied to the NASA appropriation bill probably will be removed by the Senate Space Committee. The real fight—and it may be close—will come, however, on the Senate floor. Any action appears to be at least a week away.

Webb Aide Expected to Take DOD Post

Robert Charles, special assistant to NASA Administrator James Webb, is in line for the Dept. of Defense job vacated by Air Force Secretary for Materiel Joseph S. Imirie. Charles, a former McDonnell Aircraft vice president, has been a consultant and assistant to Webb since September, 1962.

Argument on Tracking Ships Continues

NASA and the Dept. of Defense still are far from agreement on the three tracking ships for the *Apollo* program. Negotiations are continuing between NASA's Adm. W. F. Boone and DOD's Dr. Albert Hall in an effort to meet the Jan. 15 deadline set by Congress. In dispute is whether the ships will be converted just for *Apollo* or whether they will be general tracking ships which could serve additional programs. Also under discussion: whether the Navy or a private contractor will operate the vessels.

NASA To Ask Bids for Cape Support

NASA expects to ask for bids in about six weeks for a launch facilities support contract at Cape Canaveral. It will include launch complex equipment operational support, propellant services, operation of precision shops, high-pressure gas converter and compressor operations, cryogenic equipment cleaning and spacecraft servicing facilities support.

NASA Plans Director Leaves Agency

NASA's recent reorganization has forced the resignation of planning official Abe Hyatt, effective Oct. 31. Hyatt submitted his resignation Oct. 16 after his post as director of the Office of Plans and Program Evaluation was split into several offices. He was offered another position but chose to return to private industry. In another reorganization move, Dr. John F. Clark will be named director of the Space Sciences program under Dr. Homer E. Newell in the Office of Space Sciences and Applications.

INDUSTRY

Competition for Lunar Rover Is Narrowed

Competition for the *Surveyor* roving vehicle development contract now is down to two firms—Bendix Systems Div. and the Defense Research Laboratories of General Motors. Winner will be selected following the completion of six-month feasibility contracts. The vehicle—which will be landed on the Moon by *Surveyor*—is scheduled for 1966 launch.

New Fix Is Planned for Titan II

Hydraulic and mechanical dampers will be employed in an effort to correct longitudinal "pogo" vibrations of *Titan II* in its next launch from Cape Canaveral, set for this week. NASA Project *Gemini* team is not fully satisfied with the pressurization techniques employed earlier to damp out the vibrations. The new damping devices are to be installed in the propellant lines of the first stage to absorb oscillations before they get to the engines—an untried technique. One danger: it might work the other way and shake the missile apart.

TRW Reorganization Not to Affect Policy

Company sources say the reorganization of Thompson Ramo Wooldridge to bring its various divisions into closer identity with the TRW corporate structure will not involve any major policy shifts. But name changes are in store to emphasize the divisions' TRW alliance.

INTERNATIONAL

Work Progresses on ELDO Second Stage

Initial research work on the second stage of the *ELDO* rocket has been completed in France by SEREB. Nord-Aviation and LRBA have been assigned charge of development and construction of the stage, designated *Coralie*. Total weight will be 11.5 tons, with nitrogen peroxide and DMH used to provide 60,000 lbs. of thrust. First stage of the rocket will be Britain's *Blue Streak*. Germany will design the third stage.

GENERAL DYNAMICS—A MAJOR FORCE
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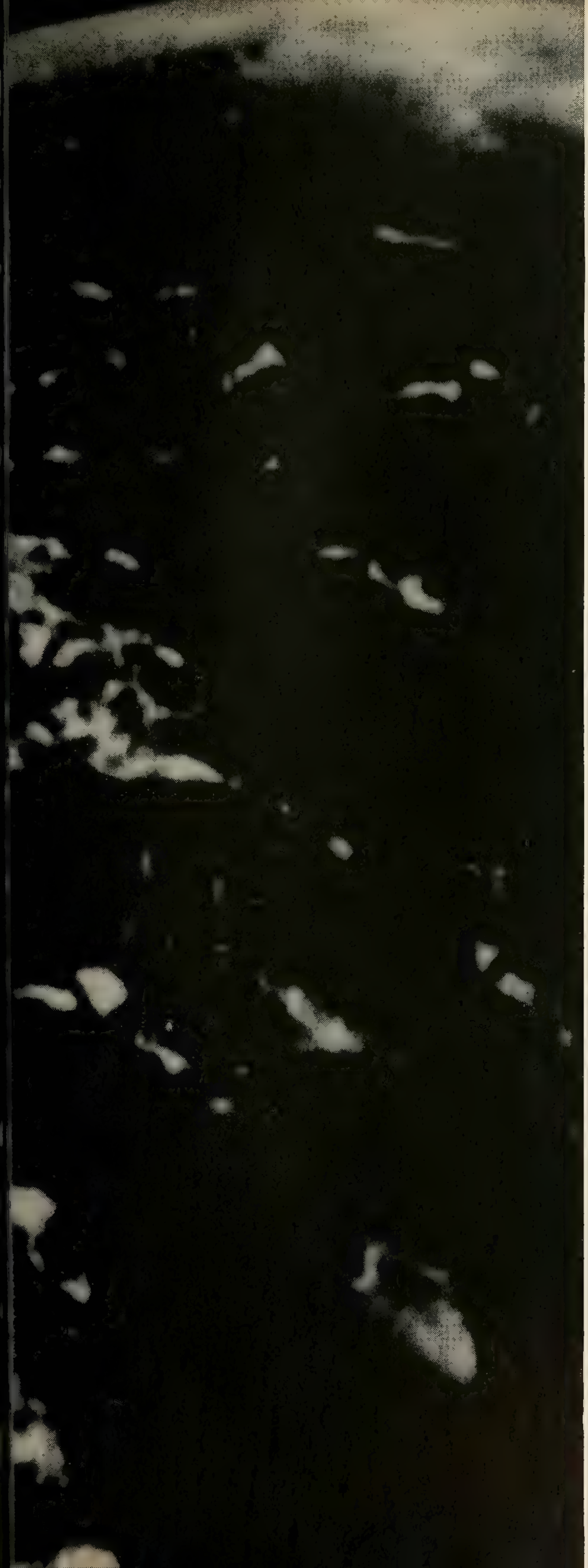

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The Missile/Space Week

NASA Names Gray

NASA has announced the appointment of Edward Z. Gray as director of Advanced Studies, Office of Manned Space Flight. He formerly served in a number of systems engineering posts at Boeing Co.

Gray will be responsible for planning and directing studies for possible future manned spaceflight projects. Studies currently under way include manned orbital laboratories, planetary missions, a lunar base, future launch vehicles and engineering systems in support of manned spaceflight.

He reports to the Deputy Director, OMSF (Systems), the post held by Dr. Joseph F. Shea before he was named last week as *Apollo* spacecraft program manager at the Manned Spacecraft Center, Houston.

George M. Low is currently acting deputy director (Systems) in addition to his duties as deputy director (Programs) OMSF.

Gray succeeds Dr. William A. Lee, who has headed the OMSF advanced study effort since early in 1962. Dr. Lee is joining the *Apollo* spacecraft program office in Houston.

U.N. May Ban Space A-Weapons

A United Nations resolution banning nuclear weapons from outer space has received public endorsement from both the United States and Russia and was being sent to the full U.N. assembly for possible ratification late last week.

U.S. Ambassador Adlai Stevenson declared that the resolution, being put forth by the 17 members of the Geneva disarmament talks, "sets forth a policy . . . already adopted by the United States."

Soviets Mention Moon Shot

U.S. ears have at last heard official confirmation of a Russian program to put a man on the Moon by 1970.

The "revelation" came from Soviet cosmonaut Yuri Gagarin and Russian Ambassador to the U.S. Anatoli Dobrynin last week in New York when Gagarin arrived from Mexico City where he had attended the International Aeronautics Federation conference.

While in Mexico City, Gagarin was quoted as saying the USSR would attempt a manned Moon shot in 1964.

Solar Flare Meeting Set

An international Solar Flare Symposium, co-sponsored by NASA's Goddard Space Flight Center and the American Astronomical Society, scheduled for three days starting Oct. 28, is expected to attract key people in the solar flare field who will try to reach a consistent understanding of solar phenomena.

Billed as "working sessions" at which about 25 major papers will be delivered, the symposium will be held at the Goddard facility in Greenbelt, Md. Scientists from the Soviet Union and other Iron Curtain countries have been invited.

New Telescope Maps Sky

An Air Force program to detect spent satellites still in orbit has resulted in mapping of about 20% of the sky and the discovery of two invisible stars.

The charting is necessary to enable the heat-seeking infrared telescope used in the program to differentiate between the satellites and other heat sources in space.

The Air Force's Cambridge Laboratories and International Telephone and Telegraph Corp. are working on the project.

Firms Vie for NASA Pact

Twenty-two firms have submitted bids on an estimated $20-million contract to provide administrative and management services for NASA's Merritt Island Launch Area.

More than 220 firms were solicited to submit proposals for the 3-year contract to handle automatic data processing, technical information and documentation services, field printing and photographic support operations.

Firms turning in proposals before the Oct. 14 deadline were: American Machine and Foundry Co.; Boland and Boyse's Tech Services System; Chance Vought Corp.'s Range Systems Div.; Chrysler Corp.; Computer Sciences Corp.; Continental Graphics, Inc.; Computer Decisions, Inc.; Cummings Consultants, Inc.; Hayes International Corp.; H.

L. Yoh Co.; IBM's Federal Systems Div.; ITT's Federal Electric Corp.; Mason & Hanger's Silas Mason Co., Inc.; Philco Corp.'s Tech Rep. Div.; Pope, Evans and Robbins; RCA Service Co.; Tech Services Corp.; Tech Productions, Inc.; Volt Tech Corp.; Wilding, Inc.; Lockheed Aircraft Service Co. and N. A. Lougee & Co.

Mack Haworth, deputy chief of procurement at NASA's Launch Operations Center (LOC), said teams will evaluate the technical and business proposals of the 22 firms in order to select one or more firms to enter negotiations leading to a contract. He said those selected for negotiations should be identified within three or four weeks.

The initial contract will cover a 3-year period, but will carry a firm price only for the first year. The second and third year prices will be subject to further negotiation before they become effective. Industry sources estimated the total cost at about $20 million.

Haworth said some portions of the work covered by the administrative and management services contract already are being performed for NASA at LOC.

Slayton to Quit Air Force

Astronaut Donald (Deke) Slayton has resigned from the Air Force effective Nov. 20, 1963.

Maj. Slayton will continue to serve as coordinator of Astronaut activities as a NASA employee at $18,000 per year.

His resignation apparently stems from the belief that he was to be removed from Air Force flying status because of a slight heart defect. NASA, however, continues to hold that he may still be permitted to take part in Project *Gemini* missions with another astronaut in the spacecraft.

Shots of the Week

The Army fired two more *Pershing* tactical missiles (M/R, Oct. 14, p. 37) Oct. 14 and 16 from Ft. Wingate, N.M., to impact points within the White Sands Missile Range. Launches were conducted under near-tactical conditions by Battery A, 2nd Missile Battalion, 44th Artillery.

Other shots of the week:

- After three abortive attempts to launch a pair of *Vela High Altitude* nuclear surveillance satellites last week, the Air Force finally boosted them into the sky at 10:37 p.m. EDT, Oct. 16, aboard an *Atlas-Agena* vehicle. Early reports from Cape Canaveral indicated the launch was a success. The twin 485-lb. packages, slated for orbits at 60,000 miles, are designed to detect nuclear explosions up to 100-million miles in space as part of the United States enforcement of the recent nuclear test ban.
- The Navy's *Polaris A2* IRBM successfully underwent firing Oct. 16 from the submarine U.S.S. Andrew Jackson while on a shakedown cruise off the Florida coast.
- NASA launched an *Aerobee* rocket Oct. 15 carrying 45 lbs. of special telescopes and cameras. Equipment was to obtain an optical image of the Sun, formed by its low energy X-rays.

Nitze Up for Navy Post

The Senate this week is considering President Kennedy's nomination of Paul H. Nitze as a successor to resigning Navy Secretary Fred Korth, who steps down Nov. 1.

William P. Bundy has been nominated to fill Nitze's present position as Assistant Secretary of Defense for International Security Affairs.

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NASA affected, too . . .

DOD Patent Policy Tightening

by Hal Taylor

A MORE RESTRICTIVE DOD patent policy is expected to result from an executive order issued by President Kennedy.

The order also is expected to force NASA to hold new public hearings before issuing proposed new patent waiver rules.

The executive order spelling out a new government-wide patent policy was issued Oct. 10. It provides that the Federal government will "normally acquire or reserve the right to acquire exclusive world-wide rights to inventions perfected under public-financed research."

Current DOD policy is directly contrary to the new Administration directive. The department gives ownership of inventions made under its R&D awards to the contractor. It reserves for the government only a license to use the patent.

Sharp changes will have to be made to bring Section 6 of the Armed Services Procurement Regulation into line with the Administration order, a DOD official said.

How great the changes will be, and when they are to be made will be determined by a special patent advisory panel established by the President in the Federal Council for Science and Technology.

The panel is charged with the responsibility of developing "by mutual consultation and coordination between government agencies, common guidelines" for implementing the policy.

There has been no indication from the council as to when the panel will start operations.

• **NASA slowdown?**—While NASA's patent regulations closely parallel the administrative order, a space agency spokesman indicated that the Presidential directive probably will slow up the agency's current move to make it easier for companies to use inventions developed under NASA contracts.

The NASA regulations provide for government ownership of inventions developed under its contracts. It provides, however, that the agency may waive such rights—sometimes even before an invention is identified as such.

The Kennedy directive, however, would give contractors greater rights only after the invention has been identified.

The spokesman said just what changes NASA will make in its regulations will depend upon discussions with the patent advisory panel.

In issuing the directive, the President said varying statutory responsibilities of government agencies do not permit "complete uniformity of practice throughout the government, but there is nevertheless a need for greater consistency in agency practices to further the governmental and public interest."

He said the government would acquire exclusive world-wide rights to inventions perfected under public-financed research when:

—A principal purpose of the contract was to create, develop or improve products, processes or methods which are intended for commercial use by the general public at home or abroad, or which will be required for such use by government regulations.

—A principal purpose of the contract was for exploration into fields which directly concern the public health or welfare.

—The contract was in a field of science and technology in which there has been little significant experience outside of work funded by the government or where the government has been the principal developer of a field and the acquisition of exclusive rights at the time of the contracting might confer on the contractor a preferred or dominant position.

—The services of the contractor were either for the operation of a government-owned research or production facility or for coordinating or directing the work of others.

The directive states that a contractor should be given greater rights only under "exceptional circumstances." Such action would require a statement by the agency head that it would "best serve" the public welfare.

• **Mitigation**—The policy does give some discretionary authority to agency directors.

They will be allowed to prescribe by regulation "special situations where the public interest in the availability of the inventions would best be served by permitting the contractor to acquire at the time of contracting greater rights than a non-exclusive license."

It also states that government-owned patents shall be made available through licensing in the shortest time possible and will be listed in official government publications.

The order also calls for annual reports on the effectiveness of the policy by the Justice Department and the Federal Council for Science and Technology. ■

First Photo: Firing Of Service Module Engine

ENGINE for Service Module of NASA's Apollo spacecraft shown during recent hold-down firing at Aerojet-General Corp.'s Liquid Rocket Plant near Sacramento, Calif. Engine is uncooled, with ablative chamber, and uses storable propellents. Altitude skirt, giving engine expansion ratio of 60 to 1, is used only when engine is fired in altitude chamber. Engine is being designed, developed and produced for Apollo by Aerojet, under contract to Space and Information Systems' Division of North American Aviation, Inc., prime industrial contractor for the Apollo spacecraft. In actual space operation, it will use a long, thin skirt to make most efficient use of the gas stream. Skirt will be made of titanium and columbium.

Chances Appear Good for More Pilot Control in Dyna-Soar Flight

THE MAN in the cockpit is steadily coming into his own as a "system" capable of taking charge of *X-20/Titan III* flights any time from boost to landing.

Encouraged Air Force sources said last week that pilot capability is expanding in two respects:

—First indications are that the *X-20* and the transtage of its *Titan III* booster can be mated without undue complication to act as a pilot-controlled unit during injection and orbit.

—The Pilot in Booster Loop (PIBOL) concept of pilot back-up control in the boost injection phase is selling itself well and apparently can be cranked into the spacecraft and booster without radical changes.

Final decisions on whether to go ahead with the proposed capabilities will have to wait, however, until completion of feasibility and cost studies on requirements for both booster and glider modifications. The Boeing Co. was reported to have completed an *X-20* study, but an Air Force project official declined to comment on the study at this time.

Results of the Martin Co. examination of modifying the transtage to accept flight control system input from the glider are not expected until early next year.

This much is clear at the moment:

The degree of success in placing the pilot in the control loop where necessary at any time during flight will have an important bearing on the Air Force's effort to justify manned space missions.

NASA is showing interest in any fall-out ideas which might be applied to the *Gemini* and *Apollo* programs.

Modification of the transtage to accept commands from both the glider's automatic systems and the pilot is not a matter of whether to do the job, but how. The restartable transtage will not only inject the vehicle into orbit, but serve as propulsion for any changes in orbit, and braking prior to start of reentry. One problem will be to make signals from glider to transtage acceptable. Computer components in the transtage were originally digital, while those of the glider are analog-based.

• **Potential during boost**—PIBOL, using extensive static and centrifuge testing, showed intriguing possibilities for pilot control during boost injection. The results affirmed under simulated conditions that:

—A pilot could exercise acceptable control under varying conditions up to 8 to 10 g's. *X-20* is planned to draw less than five.

—Attitude control capability on two axes would give a greater degree of survivability through critical stages of the flight, such as the "high Q" area of greatest dynamic stress on the vehicle.

—A pilot could prevent aborting a mission by detecting and correcting aberrations which would cause an automatic system—unable to make accurate corrections—to abort.

The booster guidance system has no back-up system, a role which tests showed the *X-20* pilots could fill within very close tolerances in making corrections for such things as slow divergence from planned profile.

Unforeseen requirements for change in orbits would require a complex and costly on-board computer system. The beauty of *X-20* with a man aboard is that it leaves such systems on the ground. The pilot can make the corrections.

PIBOL did not include the possibility for control over propulsion during boost injection because the solid stages of *Titan III* do not have restart capability. But the project reportedly took into account engine shut-down.

Investigation has gone into the ability of pilots to recognize propulsion failures and take corrective action.

The upshot of the whole examination of *X-20* pilot capability, it is hoped, will make the system far more flexible and reliable than the *Mercury*. ■

NASA Looks to TAD for Big Thrust

NASA IS SWITCHING to *Thrust Augmented Delta (TAD)* as the booster for its medium-sized scientific and application satellites.

The move to the nation's first combined liquid/solid-propelled booster will provide an additional payload capability of about 200 lbs. in a 300-mi.-high orbit.

A NASA spokesman said that many of its space shots with the regular *Delta* booster have been "marginal" in terms of payload capability. He added that the agency expects to use *TAD* in almost all its medium-sized satellite launches in the future.

Programs certain to use the new booster are the *Syncom* communications satellite, the *Bios* satellite series, the *Orbiting Solar Observatory (OSO)*, *Tiros* and the *Interplanetary Monitoring Probe*.

An official announcement of the action is imminent. It will probably mean that NASA will sign a new contract with the Douglas Aircraft Co., prime contractor for *TAD*. The same booster is called the improved *Thor (TAT)* by the Air Force, which uses it to launch some secret satellites.

The new booster has a payload capability of 1,000 lbs. in Earth orbit, compared to 800 lbs. for the regular *Delta* launch vehicle.

In terms of thrust, the first stage is almost twice as powerful.

Three Thiokol TX33-52 solid-propellant rocket motors strapped to the booster, in addition to its basic Rocketdyne MB-3 liquid-propellant engine provide the first stage with a thrust of approximately 330,000 lbs., compared to its previous thrust of 170,000 lbs.

To be operational soon . . .

Mk 45 ASTOR Now in Production At Westinghouse

THE NAVY'S NEW Mk 45 *ASTOR* wire-guided torpedo is now in production and is expected to be declared operational soon. Still undergoing final system tests, the underwater-to-underwater missile ultimately will be deployed aboard all hunter-killer submarines.

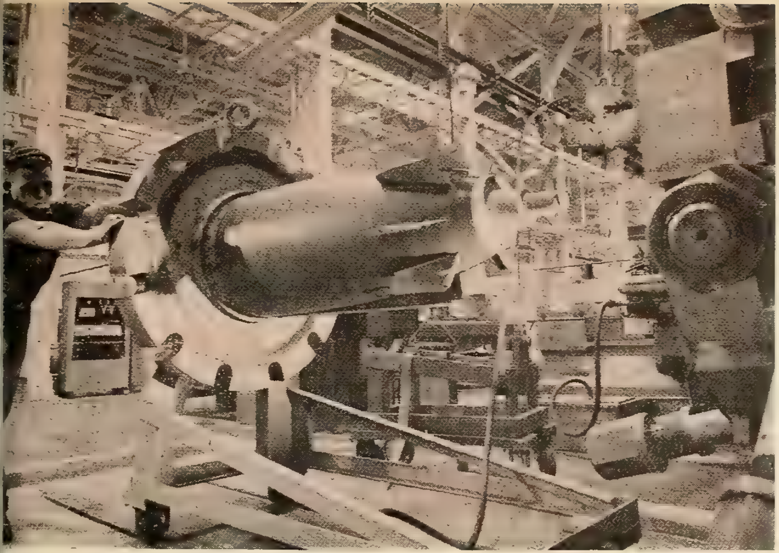
Developed by Westinghouse Electric Corp.'s Ordnance Div. in the Baltimore Defense Center, the electrically powered high-speed torpedo carries either a conventional or nuclear warhead. Performance details are extremely limited, but it is believed that the system is effective over a range of 11 n.mi. against either surface or underwater craft.

ASTOR is nearly 20 ft. long; weighs well over 2,000 lbs. The eight-fin tail, center, and nose sections all are fabricated of aluminum.

The control subsystem, located in the tail section, is inertially stabilized for roll and pitch and it automatically compensates for motor vibration and the effects of wave and current action.

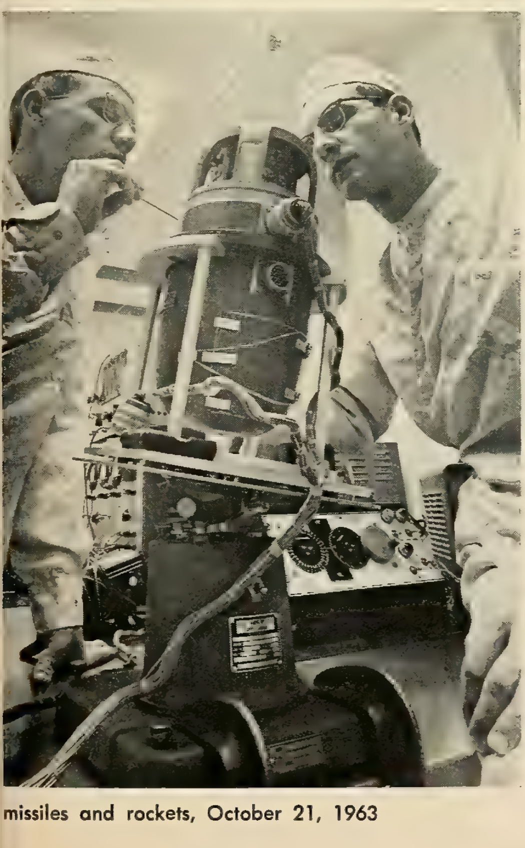
The shipboard fire-control electronic system for the Mk 45 torpedo was developed for the Navy by Sperry Gyroscope.

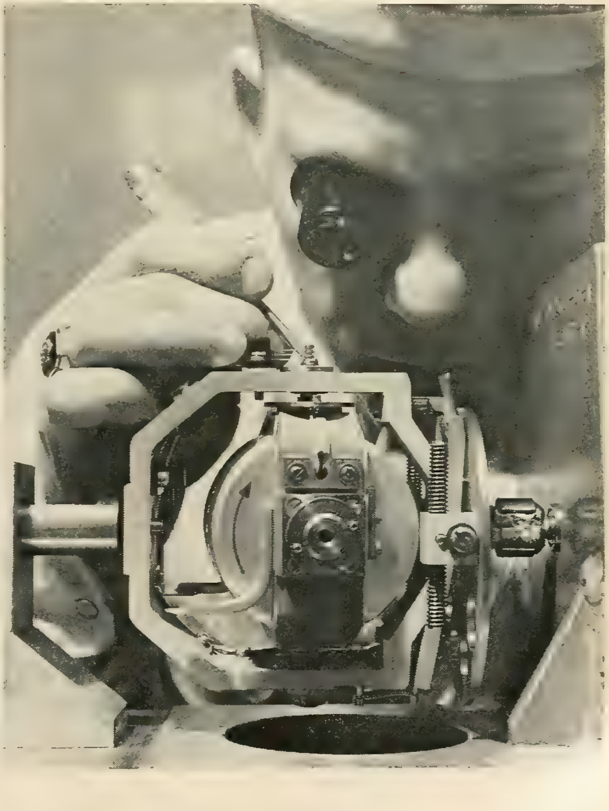
TOP LEFT: Parts of the Navy's ASTOR torpedo begin to take shape on machining lathes at the Westinghouse Baltimore Defense Center's Ordnance Div. In the foreground is a tail cone that houses propeller shaft and control mechanisms. Nose cone section (center of photo), and the center (background, top of photo) or "after body" of the weapon are shown being fabricated. Machining tolerances are such that like sections will be interchangeable. LEFT: Fins are welded to tail cone in a semi-automatic operation. Outer casing or shell of torpedo is made of aluminum, and crack-free-welding requires that arc be surrounded by an inert atmosphere. Here it is a mixture of non-flammable argon and helium.



ASTOR TAIL CONE is ready for hydrostatic pressure test. After the tail cone is inserted into the testing chamber, large bolts at right will be tightened, chamber will be flooded with water, and pressure applied. Any leakage will be cause for component rejection.

FREE GYROSCOPES, rotating at 24,000 rpm, are used in Mk 45 torpedoes for inertial stable reference. Roll, pitch, motor vibration and wave and current motion must be countered after launching from submarine.





CONTROL INPUTS to the torpedo are directed by wire from shipboard fire-control system to this steering subsystem. The unit, mounted on a test stand, is shown here being aligned by Westinghouse technicians.

By Seitz, Wiesner . . .

House R&D Subcommittee Told Federal Funding Reaching Peak

by Heather M. David

TOP ADMINISTRATION scientists have testified that the long upward trend of Federal support for research is finally leveling off.

Dr. Frederick Seitz, president of the National Academy of Sciences, told the new R&D subcommittee of the House Science and Astronautics Committee that national research and development spending—which has doubled every four years since World War II—cannot continue at this pace or it would consume the entire Gross National Product within 20 years.

At present, R&D spending accounts for about 3% of the GNP. Dr. Jerome Wiesner, Presidential science advisor, pointed out that the most successful industrial concerns have an R&D investment of about 5%.

● **Selectivity stressed**—Both scientists said that the leveling off must result in more selectivity in choosing which research projects to support. Applied research especially must get a hard look, they said, because of the magnitude of the programs and the tremendous costs involved. Wiesner said that 15 years ago there was justification for more development than the country could use, but that this is no longer true.

For instance, Wiesner said, there may be hundreds of potential uses for the laser, but the government cannot exploit them all. While there is no single criterion that can be used in making a choice, the government must attempt to forecast the consequences of not pursuing certain programs. He added that in some cases the national welfare can be hurt more by cutting out a $500,000 program than by dropping a $100-million program elsewhere.

Seitz cautioned against supporting the "glamorous" types of research such as high-energy physics and astronomy without proper justification for the expense. "It is often possible to endow studies . . . which involve large and specialized equipment, with a particular type of glamor derived from the size of the gear or the magnitude of the effects that are observed rather than from the contribution to knowledge.

"Less expensive basic science may seem, superficially, to be less glamorous, even though its results can have a more far-reaching effect upon our minds and lives," he said. He also warned against an imbalance of emphasis toward the space sciences, unless the other scientists also receive the support they need.

The testimony of the two scientists was the first in a Congressional drive by a number of committees to investigate the burgeoning science expenditure, which this year totals about $15 billion. Of this, the Department of Defense supports $7.7 billion, NASA $4.2 billion, and the Atomic Energy Commission $1.5 billion. Thus, Wiesner pointed out, the majority of the R&D budget may be disproportionately security-oriented.

The emphasis the two scientists put on more support of basic research echoes what many U.S. scientists have been saying in the past few months. However, in Wiesner and Seitz they may have found their most influential spokesmen.

● **Goals set**—Wiesner outlined a number of tasks he suggested that Congress consider in its effort to get a leash on science spending:

—Improving means for maintaining good R&D efforts without serious gaps and with minimum duplication.

—Perfecting methods of choosing the nation's scientific and technical objectives.

—Clarifying roles of government, industry, universities and non-profit institutions. Wiesner noted that the most productive government laboratories were those connected in some way with universities.

—Improving communications within the scientific community and between it and the public.

Wiesner concluded with a special appeal for Congress to adjust the salaries of top government executives, which he noted were still not in line with industry salaries. ■

IBM Wins $75-million CPIF Saturn Contract

INTERNATIONAL BUSINESS Machines Corp.'s Federal Systems Div. has been awarded a $75-million contract for electronic equipment and support in NASA's *Saturn IB* and *Saturn V* launch vehicle program.

The cost-plus-incentive-fee award will cover integration and checkout of the instrument units, design and manufacture of their data adapters, and development and production of their digital guidance computers. A major portion of the work will be done at IBM's Owego, N.Y., plant.

IBM has been engaged in development, manufacture, and evaluation of *Saturn I* guidance hardware for about three years. The *Saturn IB* and *Saturn V* work is an outgrowth of this program, NASA said.

The instrument unit mounted between the *Apollo* spacecraft and the S-IVB stage of the *Saturn IB* or *Saturn V* rocket contains eight systems—guidance, control, electrical, measuring, telemetry, radio frequency, structural and environmental. Interconnected equipment, part of the instrument unit system, is to be located in the vehicle stages. The data adapter, now in the early design stage, is the central unit which adapts the various components and subsystems to each other for a particular mission.

The digital computer is the overall system memory and timing source. It receives input signals from the data adapter and supplies output signals to appropriate parts of the overall system.

Construction and assembly of the instrument unit will be performed by the Marshall Space Flight Center, using components developed and manufactured by several contractors. IBM will furnish the data adapters, guidance computers and the total integration and checkout effort.

At Colorado symposium . . .

AF Outlines Five-Year Research Plan

OAR package projects 40% boost in geophysics work, 30% in other physical sciences; effort vital to epochal Project Forecast

by David C. Breasted

COLORADO SPRINGS, COLO.—The Air Force's Office of Aerospace Research hopes for a 40% increase in geophysics effort as one trend across the wide spectrum of its research program in the next five years.

The physical sciences, excluding geophysics, in fields of interest to the Air Force would be a second area of marked activity increase—about 30% under a proposed OAR five-year plan.

These, however, are only two facets of a general rise in the research level. The five-year package lays out the needs for fundamental research in a decade of burgeoning technological demands and tightening purse strings.

OAR heads are seeking Dept. of Defense support for the integrated research plan, the first comprehensive statement of projected OAR aims in research and exploratory development.

Research, unlike systems development, cannot be planned in the strict sense, but must be planned for. As one OAR scientist put it, "it's like trying to predict the weather in Texas."

The plan is therefore termed "loose leaf," and 46 changes have been made in it during the year in which it has shaped up.

OAR heads were willing to discuss the plan in broad outline here at the recent Air Force Science and Engineering symposium, attended by 400 top military and civilian scientists.

The five-year plan would more than triple estimated OAR research funding by 1969. Developers of the plan, built from the laboratory up, believe that it presents a convincing relief map of the research terrain ahead, and a salable program in the stiffening competition for research funds.

The primary emphasis, however, is not upon funds but upon people and what kind will be needed.

OAR has published a condensation of its original 264-page plan in a 64-page booklet, "Air Force Research Objectives," now available to industry. The contents reportedly bear close resemblance to the "Technical Objectives" of the complete and previously classified plan.

While researchers are reluctant to stress particular areas in interlocking scientific investigation, they cited several in which the Air Force obviously has pronounced interest. Among these are solid-state physics, quantum electronics, fluid dynamics, ionospherics physics, and space physics. Of particular moment will be research in energetics and plasma dynamics.

Under energetics, the Air Force groups such subfields as fluid, solar, heat and chemical energy conversion, and combustion dynamics.

Its activities at the Cambridge Research Laboratory, Cambridge, Mass., and the Aerospace Research Laboratory, Dayton, Ohio, are expected to increase substantially.

● **Sweeping self-analysis**—The five-year plan has an important bearing on the Air Force's Project Forecast, a top-priority study to determine what the posture of the Air Force should be in the next decade.

The OAR plan is designed to provide the research support demanded as the shape of the Air Force emerges not only in this decade, but far into the 1970's.

In a keynote address to the symposium, Lt. Gen. James Ferguson, AF deputy chief of staff for R&D, termed Project Forecast "one of the most significant self-analyses undertaken by the Air Force." He said the classified project, due for presentation soon, could "conceivably" rank with studies by the late Theodore von Karman and John von Neumann at earlier crossroads in Air Force history.

Ferguson, in stressing the need for follow-on manned aircraft systems, said that "we may find hybrid air- and spacecraft filling this role."

He further stressed that in the face of the prohibitive cost, the Air Force will tend to forego concurrent system development in favor of prototype development. This could affect not only aircraft, but missile development.

Ferguson also emphasized "quiet" progress in improving the state of the Air Force's in-house research programs and the caliber of its researchers. The proposed five-year plan would seek to raise the quality of in-house research first, before addressing the quantitative aspects of the overall research effort. "You're only as good as the people you have," said one OAR director. The plan therefore starts with the people needed in the various disciplines and fields of interest to the Air Force, and then proceeds through the facilities, and lastly the money needed.

● **Target areas**—Ferguson and Maj. Gen. Don R. Ostrander, OAR commander, had this to say on research topics of general interest:

—*Electromagnetic pulse:* On the possibilities of EMP damage from high-yield explosions to missiles in hardened sites, Ferguson said this is "not a grave worry at this time."

Ostrander said that shielding over-design is regarded as adequate.

—*Electrical propulsion:* "Hampered by the lack of an adequate power supply," Ostrander said, "it looks like we ought to invest more in basic research in energetics."

—*Nuclear Propulsion:* A gas-core reactor remains the most promising avenue of exploration because it would not spew fission products into the atmosphere.

Ostrander also indicated keen interest in better understanding of combustion and fluid dynamics.

Among papers presented at the symposium were:

—A Space Systems Division study showing that with continued advances in flare research, it will be possible by 1970 to provide five-day forecasts of periods with solar proton showers [illegible] forecasting devices for solar flare events will help protect men in space.

—A Space Systems Div. presentation gave concepts for closure systems to protect silo cavities up to 12 ft. in diameter at the surface against overpressure up to 10,000 psi. ■

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New Castable Glasrock — A remarkable new refractory ceramic fused silica material ideal for test stands where repeated high heat protection is required. Also capable of withstanding abrasive effects of solid propellant blasts.

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Technical Countdown

ELECTRONICS

Miniature Fuel Cell Exceeds Requirements

A three-element solid-electrolyte fuel cell developed by Westinghouse Research Laboratories has been experimentally evaluated for aerospace use by the lab under an Air Force contract. Program goal, satisfactorily reached according to developers, was a simple, small fuel cell capable of producing at least 125 watts/pound and 100 amps/sq. ft. of fuel cell area in a space environment. The final experimental model weighed 0.2 oz., occupied 0.33 cu. in. and produced 2 watts of electrical power. Scaled-up versions, capable of up to 100 watts output, are now under construction by the lab. The electrolyte used was a solid ceramic made of zirconium and yttrium oxides.

New Laser Communications Successful

A new non-coherent laser data transmission system, using uncooled gallium-arsenide diode techniques, has been successfully operated by General Electric Co. scientists. The development model has produced a 12-mc bandwidth to date, but much larger figures are anticipated by the firm. In lab tests over a 12-ft. path, GE said the system transmitted and received a high-resolution (800 lines) TV picture with a 35 db S/N ratio and no perceptible degradation in picture quality. Eventually, the effective range will be in excess of 10 miles, GE claimed. The transmitter, including parabolic reflector, GaAs diode, driving circuitry, and power supplies, measures 7 x 7 x 12-in.; the receiver measures 8 x 8 x 24-in.

Rendezvous Control is 'Fail-Safe'

Tests by a NASA team using Ling-Temco-Vought's unique manned spaceflight simulator in Dallas, show that pilot skill, manual controls and a spacecraft radar are sufficient to achieve space rendezvous if the control electronics fail. During the study, astronaut subjects assumed that various portions of the guidance and navigation system were inoperative. They repeatedly achieved rendezvous, said NASA officials, by processing their own guidance data from radar information with a simple circular slide rule.

Adaptive Trainer To Be Studied

The feasibility of developing a training system that would adapt itself automatically to the efficiency level of its human operator will be studied by the Otis Elevator Co.'s Defense and Industrial Div. for the Navy. Scores of test subjects will be used in the study to work with a simplified special-purpose analog computer programmed for use as a training research tool. The system will be tied to an operator control stick through a variety of adjustment circuits that will automatically increase or decrease operating difficulty of the control mechanism.

SPACE OPTICS

Recon Camera Shutter Advance Revealed

Engineers at Graflex, Inc., in Rochester, claim that nearly square wave response in a mechanical gate has been obtained with a new between-the-lens shutter system which allows 0.001-sec. shutter speeds with a 1-in. lens aperture. Shutter blade cycling action, Graflex said, is 2-3 times faster than conventional between-the-lens systems. Speed range for the same mechanism is from 0.001-2 sec., with high-speed action achieved without the need of lubricants. In the drive mechanism, each of four separately-mounted shutter blades moves elliptically, avoiding abrupt stop and reverse action. The movement allows the shutter mechanism to accelerate to top speed before the blades open. Final braking action is achieved after the blades close. The device, designed for reconnaissance missiles and drones and also as an IR gate aboard military satellites, is reported to have an MTBF of about 50,000 cycles. Roles in low-energy laser gating and other IR gating applications are being pursued.

Modified Cassegrain Broadens Image Field

A new 1,000-mm Cassegrain-Coude reflector astronomical telescope, developed by Carl Zeiss, Inc., has been installed and is now operating at the Caracas, Venezuela, Observatory. Through use of the modified Cassegrain system, the usable image field has been extended from a few minutes of arc, common with conventional designs, to 23 minutes of arc. The system as modified includes a spherical primary reflector and a deformed secondary reflector afocal system. A larger image angle is a key to improved extragalactic photographic capability. The primary mirror measures one meter in diameter. The hyperbolic secondary mirror has a diameter of 300 mm. Wave deviation over the surface of the primary mirror reportedly is accurate to 10 nm (100/1,000 mm).

SPACE MEDICINE

NASA Looking at Headband Biosensors

Tiny biosensors, possibly employing lasers as light sources, may be used for continuous monitoring of heart and respiration rates of astronauts. Dr. Robert Shaw, San Francisco Presbyterian Hospital, has submitted an unsolicited proposal to NASA for the monitors, which would be worn in the astronaut's helmet headband. Wavelengths of 1,000 and 650 millimicrons look promising, Shaw said.

ADVANCED MATERIALS

Tory II-C High Temp. Parts Delivered

More than 100 coated columbium-alloy parts that will be used in the high-temperature zones of *Tory II-C* have been delivered by Ling-Temco-Vought, Inc., to Lawrence Radiation Lab for dynamic testing. The parts were coated and static-tested by LTV under a $200,000 LRL contract. (*Tory II-C* is the nuclear-ramjet reactor being developed to prove feasibility of use of such a system for the Air Force's Low-Altitude Supersonic Vehicle. *Tory II-C* will be tested this winter under full power and is a flight model follow-on to the *Tory II-A* reactor, ground-tested at partial power by the AEC in Nevada.)

New Coatings Boost Superalloy Temperature

Superalloys capable of withstanding temperatures as great as 2,200°F may be the result of a new coating agent developed by Chromalloy Corp. Called SUE coating, the cladding material is especially designed for TD (thoria dispersed) nickel, and the combination promises to find application in the missile/space and nuclear fields. Bare TD nickel oxidizes in a few hours at high temperatures, but coated test bars of the alloy have withstood 2,200°F for 100 hours with only slight weight gain and slight substrate oxidation. Thermal shock tests of SUE-coated TD nickel turbine vanes—two forged and one fabricated of sheet metal—showed the following capabilities: 600 cycles between 2,000°F and ambient temperature, followed by 300 cycles to 2,200°F before the coating showed signs of failure.

Bendix Star and Planet Tracker Program Locks on New Detector Device

'Channeltron' image dissector is key to future systems; firm claims continuous-strip electron multiplication leads to major reliability gains; use proposed in AOSO, sounding rockets

by Michael Getler

TETERBORO, N.J.—Engineers at Bendix Corp.'s Eclipse-Pioneer Div. here report that all their firm's new spaceborne star and planet tracker systems will be designed around a new detector element which shows major improvements in size, weight, power, and reliability, and matches performance levels of more conventional devices.

The new element, called a channel multiplier detector, or "channeltron," has already been proposed for use as a Canopus seeker aboard NASA's *Advanced Orbiting Solar Observatory* (*AOSO*) and in sounding rockets.

Bendix describes the detector as an improved, high-reliability image dissector which uses magnetic deflection and electrostatic focusing techniques to direct electrons emitted from the tube's photocathode to the multiplier section.

The front end, or image dissection portion, of the tube is very similar to conventional devices. The major savings in weight, size, and power, and the superior reliability—estimated to be about 100 times greater than that of conventional systems—result directly from the electron multiplier section.

The multiplier is a small, slightly curved glass cylinder, about 1 in. long with a .017-in. inside diameter. The inside of the tube is coated with a thin-film metallic oxide semiconductor material which acts as a secondary electron source. Electrical contact to this inner resistive surface is made by coating the ends with conductive paint and attaching leads. Actually, only one connection is within the multiplier section. A potential difference of 1,000-2,000 volts is maintained between the ends, causing a current on the inner surface. This action forms a uniform axial electric field along the length of the tube.

• **Multiplier action**—Electrons from the photocathode, excited initially by impingement of energy from the external light source being tracked, are directed via the magnetic beam and electrostatic focusing to the aperture plate and strike the inner wall of the multiplier.

An electron moving with sufficient energy and hitting the thin film coating will generate a secondary electron, beginning a cascading effect which ultimately can produce gains up to 10^6, Bendix says. By proper proportioning of tube diameter and field strengths, sufficient energy can be imparted so that on the average each electron creates more than one secondary electron. Bendix engineers say that between 100,000 and 1 million times the number of entering electrons actually hit the collector electrode.

TYPICAL CHANNELTRON SPECIFICATIONS

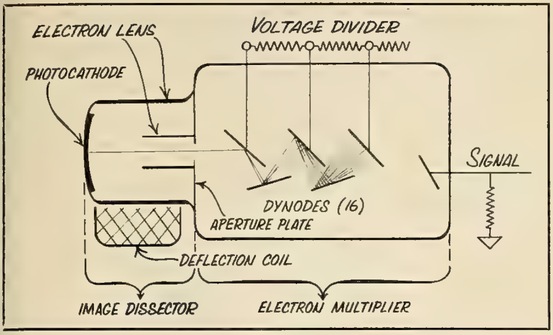
PHOTOCATHODE	S 11 (Sb Cs)
Faceplate	7052 Glass
Spectral resp.	3200–6500 Ang.
Active cathode diameter	19 mm
Luminous sens.	50 ua, lumen
Radiant sens.	.05 amp/watt @ 4400 Ang.
Quantum efficiency	15% @ 4400 Ang.
CHANNEL MULTIPLIER	
Resistance	1.3 x 10^8 ohms
Design voltage	2,000 volts D. C.
Design current	1.5 x 10^{-5} amp
OVERALL GAIN	10^5
Anode sensitivity	5.0 amp/lumen
Total dark current	10^{-11} amp @ 20° C
Equivalent anode dark current input	2 x 10^{-15} watts
OVERALL LENGTH	3⅝ inches
O. D.	1.125 inches
Weight	1.5 ounces

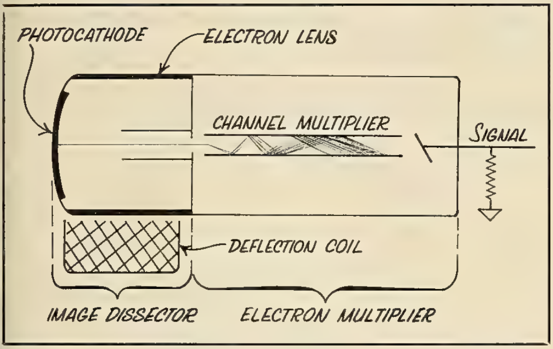
Creation of the secondary electron generally imparts a transverse velocity which carries it across the tube where another collision will take place, while the longitudinal electric field accelerates the electrons down the tube towards the collector.

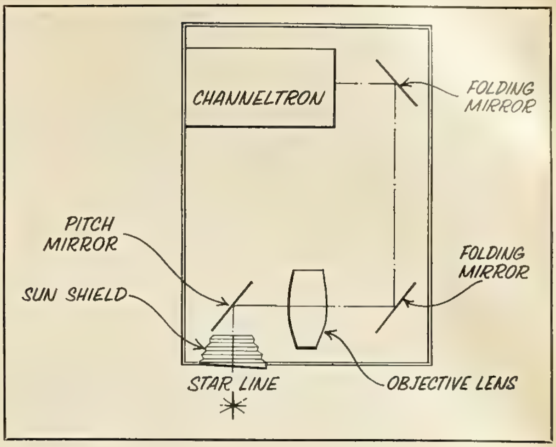
The multiplier tube is slightly curved so that no electrons can move straight through the device without electron-creating tube-wall collisions.

In effect, the channel multiplier replaces the multiplicity of dynodes upon which more conventional detectors rely for electron multiplication. In standard detectors, Bendix notes, different voltages must be applied to each dynode. The channeltron multiplier removes this requirement, along with the associated voltage divider hardware. It also obviates the need for separate glass-to-metal seals for each dynode throughout the conventional vacuum envelope.

• **Development cycle**—Development of this device at Bendix is actually







TOP LEFT: Conventional image dissector photomultiplier uses multiplicity of individual dynodes requiring voltage divider hardware and separate vacuum seals. BOTTOM LEFT: Bendix claims that Channeltron, through use of relatively simple continuous-strip multiplier section, leads to reliability increased by factor of 10. ABOVE: Simplified layout of channeltron and fold optics system proposed for use aboard AOSO.

an outgrowth of earlier work on continuous-strip electron multipliers done at the firm's Research Laboratories in Southfield, Mich. The effort gained additional momentum as a result of work Eclipse-Pioneer is doing for NASA aimed at development of a back-up star tracker for the primary device being built for the *Orbiting Astronomical Observatory* (M/R, Dec. 4, 1961, p. 16) by the Kollsman Instrument Corp.

The *OAO* tracker being built by Bendix uses a photomultiplier supplied by ITT Corp. Much of the impetus for the continued channeltron development was based on the realization that the photodetector section of the tracker system appeared to be the best place to effect major improvements in size and reliability. As an example of the size gains possible, Bendix engineers theorize that if the channel multiplier were applied to the *OAO* system (which it will not be) it would shrink the size of the unit by one-third.

Bendix is moving to incorporate the new image dissector tube and associated electronics (high-voltage supply, sweep generator, preamp, demodulator, and telemetry conditioner), into a universal-type channeltron module which would be applicable to a wide range of strapped-down or gimballed tracker systems.

The module, according to engineers here, could be packaged in a 4-in. x 5-in. x 5-in. volume, not including optics, weighing about 4 lbs, and requiring 3 watts power. Using an in-line type of optics, in which an objective lens focuses directly on the photocathode, the system would reportedly provide a ±4 deg. field-of-view, ±15 arc sec. accuracy, and be able to detect stars of the +3 magnitude or better (distinguishing between stars of one-magnitude brightness difference).

Trackers designed around channeltron are aimed basically at the strapped-down type of space navigation systems, using either relatively simple in-line or folded optics schemes, or a variety of front-end lens barrel attachments for specialized requirements. Although a strapped-down system makes the most of size advantages, channeltron could operate with gimballed systems where increased viewing fields are required without proportional losses in tracking accuracies.

- **Specific uses**—For *AOSO* use, Bendix has proposed channeltron for single (roll) axis strapped-down stabilization, operating with a folded optics arrangement. Minneapolis-Honeywell Co. is stabilization and control system subcontractor to Republic Aviation Corp., *AOSO* prime. Bendix says the system, including optics, will weigh only 5 lbs. and require 3 watts power, and can be packaged in a 5-in. x 5-in. x 7-in. volume. Only moving part in the system is the pitch mirror drive assembly (see diagram).

Channeltron is inherently a two-axis sensing device which can be used for either one- or two-axis stabilization. Three-axis stabilization would require more than one tracker.

A two-axis stabilization system has been proposed for final pointing of spectrometers carried aboard sounding rockets.

Use of electromagnetic cathode scanning techniques rather than electrostatic methods was also chosen with an eye towards improved reliability, Bendix says, although it may inhibit use of channeltron aboard certain spacecraft which have extremely low magnetic field generation requirements (M/R, Sept. 9, p. 22). Three cylindrical, nested magnetic shields surround the tube to keep the Earth's magnetic field from disturbing the image dissector balance and to contain the instrument's magnetic flux.

Using a 1-in.-dia. cathode, the complete channeltron tube would measure 3⅝ in. long, with an outside diameter of 1.25 in. The device weighs 1.5 oz. ■

New Non-Coherent Generator Eyed for Communications, Missiles

Marshall Labs' 'Enertron' has superior energy conversion efficiency; developers believe it is inherently better than lasers for many uses

by Rex Pay

LOS ANGELES—A newly developed non-coherent light-energy generator could provide a practical means for employing radiations in the ultraviolet, visible or infrared range for radar, communications and even active missile guidance.

The energy source—a multi-electrode, gas-discharge tube immersed in a high-viscosity liquid—is called an "Enertron" by its developers at Marshall Laboratories, a Marshall Industries subsidiary at Torrance, Calif. It converts relatively low-average electrical input power to very high pulsed output power. The emitted energy, produced through the quanta exchange of energy in the arc discharge, is characterized by very broad, controlled spectra.

Triggering, pulse-width and repetition rates are controlled with great precision, Marshall Labs officials report.

Energy conversion efficiency is claimed to be equal to that of a magnetron (better than 50%) and considerably greater than that of a conventional laser.

Capable of radiating 50-megalumen light pulses at a 10-kc repetition rate, the Enertron, developers believe, is inherently more suitable than any laser for many space communications or ranging applications.

Since the Enertron output is incoherent—in contrast to the coherent laser emission—diffraction-limited optics are not employed. Marshall says beamwidths of about 0.5 degree probably are obtainable.

Energy pulses of one-microsecond width have been produced with the Enertron and peak radiated powers of about 1.5 megawatts have been obtained from peak inputs of 3 megawatts electric power. (Average power inputs have been varied from 5 to 1,000 watts.)

Considerably higher radiated power is forecast by Marshall Labs, and repetition rates as high as 45 kc are predicted.

ENERTRON TUBE consists of low-pressure gas discharge tube immersed in a liquid of low viscosity. Immersion in liquid enables tube to withstand very much higher internal pressures without shattering. High flash repetition rates are achieved by means of a firing-electrode system in the base.

- **Tested by Navy**—With a simple receiver consisting of a dime-store lens, a beer can, a silicon solar cell and a two-transistor cascade amplifier, the Enertron provided voice communication over 150 vacuum miles during a recent Navy test.

In this experiment, the transmitted beam spread over a 90-degree solid angle.

In another test by Marshall, the same transmitter was placed 500 ft. from the receiver in direct line with the Sun's disc and communication was still achieved.

This suggests that systems of this type would have no problem in penetrating the plasma sheath of re-entering space vehicles.

- **Typical early applications**—A typical Enertron space-communications transceiver would occupy about one cubic foot and weigh less than 17 lbs. It would consist of an Enertron tube and its associated firing and modulation circuits, served by one lens system; and a silicon mosaic detector, video amplifier, pulse lengthener, demodulator and audio unit, served by a second optical system mounted parallel to the first.

An Enertron system might also be used as a command guidance link for a missile system. It can provide a relatively narrow beam by means of a very simple lens or mirror system that is substantially smaller and more easily controlled than a microwave antenna.

While the most obvious application of the Enertron to missile guidance would be in a beam-riding system, command guidance is also practical. Because the Enertron generates high-powered signals and the signal train is pulsed, it is possible to utilize in the missile an unchopped, solid-state silicon detector element backed by a frequency discrimination circuit to separate the Enertron commands even against a pure Sun background.

In either a beam rider or a command guidance mode of operation, missile guidance functions would be parallel to microwave systems. The major gains over a microwave system would be elimination of IF strips in the receiver, reduction in transmitter antenna size, reduction in transmitter size and weight, and greater operational effectiveness in the presence of countermeasures.

Another application of the Enertron would be in surveillance photography—as an illumination source that could not be perceived by the eye. A one-microsecond flash of light is undetectable by the eye, but can be used to produce a photographic image.

- **Design variations**—Enertron tube design depends greatly on its application. Generally, the bore of the tube is between 3 and 10 mm and gas pressure is less than atmospheric—typically 100 to 200 mm Hg.

Light from the tube has a broad spectrum spread fairly evenly over a large number of wavelengths. There are also high-intensity lines superimposed on this continuum. Interestingly enough, these show no pressure broadening.

For most applications, a combination of a host gas and a dopant fills the tube. For a strong visible output, a xenon host would be used; for an ultraviolet output, neon might be used as a host; for infrared, any host that did not give off visible light would be suitable.

Much of the work at Marshall Laboratories has centered on development of extremely powerful infrared sources that would drastically reduce the sensitivity requirements of infrared surveillance, ranging, guidance, or communications systems. For such applications, an organic dopant is used. Under normal conditions it need not be gaseous.

Input voltages can go as high as 100 kv but, for convenience and low cost, the input voltage to the tube is generally kept below 5 kv. Currents are typically in the region of a kiloamp.

At the high energies involved, the host gas becomes fully ionized and the fast-moving electrons in the discharge excite the dopant atom, which may not be ionized. Organic compounds are used as dopant for infrared tubes, as the emission lines of many organic compounds occur in this region of the spectrum.

So far, Marshall Laboratories has investigated Enertron systems that provide various types of spectral output in the region between 1,500 Angstroms (ultraviolet) and 35 microns (infrared). Much of the infrared work has been concentrated at wavelengths of 15 microns and lower.

However, William H. Long, Manager of the Military Projects Laboratory at ML in charge of the development of the Enertron, considers that the possible range of outputs of such systems is much higher, and that they may eventually bridge the microwave-visible gap.

In Enertron tube design, steps are taken to avoid X-ray emission, and the company is not developing tubes as sources in this region of the spectrum. By suitable electrode arrangement, the electron velocity at the collector electrode in the tube has been reduced to a very low value, avoiding X-ray emission by bombardment.

Different host gases and dopants give different radiative efficiencies. The 50% efficiency quoted is not achievable for all types of spectral output.

Marshall Laboratories says the microsecond pulses through the tube are virtually square waves, produced by conventional radar delay-line techniques.

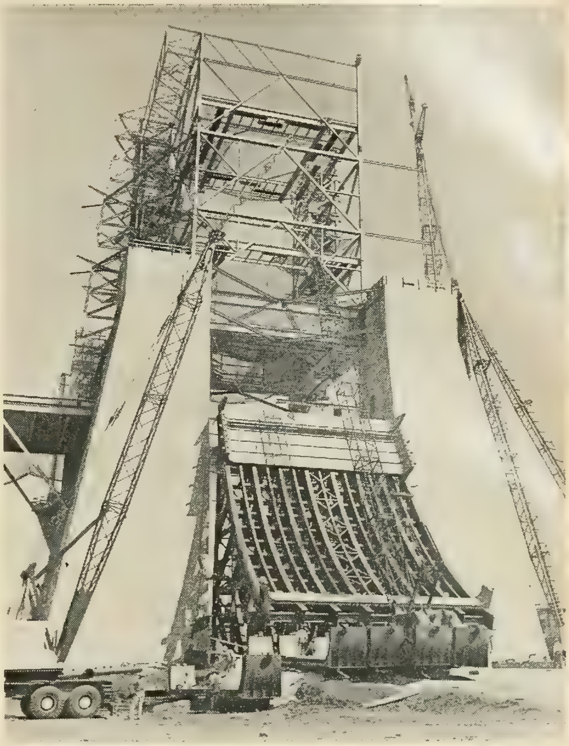
Narrowing the pulse width of the electrical energy applied to the tube varies the energy density slightly and tends to shift the spectrum up or down. The high velocity of the electrons in the Enertron tube makes the shift quite small compared with that in conventional flash tubes, and it can be compensated for by adjustment of dopant density.

Adjustment of dopant density changes the characteristics of the tube and may call for compensatory adjustments in tube dimensions. The problem facing the tube designer is to produce the maximum efficiency from a tube of a given maximum size and operating voltage.

Although the Enertron has a panchromatic output, a high-intensity line at a certain region in the spectrum can be produced and filtered out from the background continuum. The receiver unit can then be fitted with a narrow band filter, so that communication is secured within a narrow spectral region.

One feature Enertron light does not have compared with laser light is the possibility of carrying extremely wide-band information. The information capacity of an Enertron beam can, however, be increased substantially over that offered by its 10-kc pulsing capability. In effect, frequency multiplexing of Enertron radiation can be carried out by the use of multiple filters. ■

Saturn V Test Stand Going Up Rapidly at Huntsville



GIGANTIC Saturn V booster test stand reaches skyward at NASA's Marshall Space Flight Center, where it is due to be completed early next year. Newly released photo shows concrete pillars nearly 150 ft. tall; atop them will be more than 100 ft. of steel superstructure; a derrick to be mounted on the steel will bring overall height of structure to 405 ft.

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Fused Silica Reflectors in Laser Test

Radiation-resistant substance developed by Corning Glass Works will go aloft aboard S-66 satellite, scheduled for PMR launch

by William Beller

THE LASER TRACKING experiment on the *S-66 Polar Ionosphere Beacon Satellite,* scheduled for fall launch, will carry arrays of small reflectors made of fused silica—the hardest and possibly the most expensive and difficult-to-fabricate glass known.

The *S-66* is to be lofted by a *Scout* booster from the Pacific Missile Range into a 600-mi. orbit inclined 80 degrees to the equator (M/R, Aug. 5, p. 21).

The laser reflector arrays, riding piggy-back, will be part of the first attempt to use coherent light to track a satellite (M/R, Aug. 6, 1962, p. 22). The laser itself, mounted on an 18-in. telescope, will be housed on a 60-ft.-high tower located 20 mi. south of NASA's Wallops Station, Va. The facility will be used to optically track the *S-66* during periods when the satellite is illuminated by the Sun and the tracking station is in darkness.

The laser technique, potentially vastly more accurate than Minitrack, the primary tracking method for the *S-66,* has the added advantage of requiring no electrical power from the satellite.

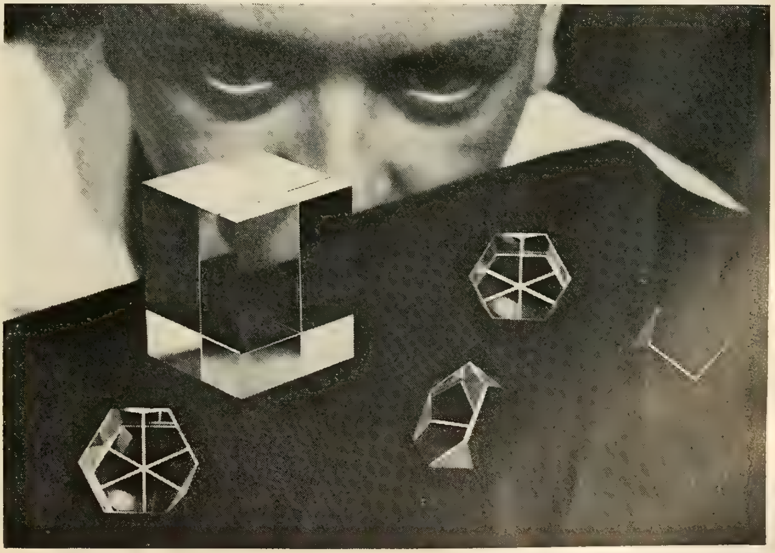
Goddard Space Flight Center is *S-66* project manager, Applied Physics Laboratory of Johns Hopkins University designed the satellite, and General Electric Co.'s Valley Forge Space Technology Center designed the laser experiment.

If the laser tracking experiment works out right, future satellites could possibly use coherent light beams to send large amounts of information. "A carrier beam transmitted to a satellite could be modulated with data and sent back to a receiver passively by reflectors rather than actively by an on-board transmitter," says John M. Walker, NASA's chief of communications and tracking. He added that by proper optical design, a modulated beam possibly could be sent to a receiver lying over the horizon.

- **Diamonds in the sky**—A total of 360 highly polished and accurately cut cube-corner, 1-in.-dia. fused-silica reflectors are mounted on an eight-sided truncated pyramid, making nine individual reflector arrays in all—the eight sides and truncated surface. The reflector assembly, sparkling in the Sun like a tray full of cut diamonds, is set on top of the 18-in.-dia. octagonal *S-66.* In the Northern Hemisphere, the assembly will be pointed toward Earth by means of a passive satellite-attitude-control-system based on the Earth's magnetic field.

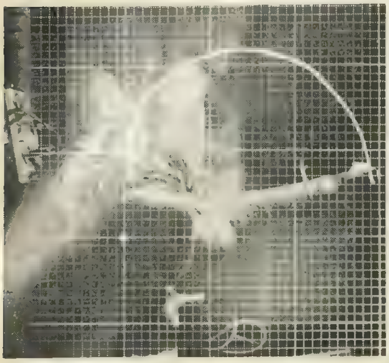
A less exotic glass than fused silica was tried at the beginning of the laser work, but laboratory experiments showed it would not stand up under space radiations. Fused silica, a Corning Glass Works product, was then specified because of the material's resistance to radiation "browning." The material also has a near-zero thermal-expansion-coefficient, along with excellent optical properties.

Fused silica, with impurity levels as low as one part in a hundred million, is one of the purest materials made by



DR. ROBERT E. LASHINE, Boxton-Beel, Inc. laboratory director, examines an uncut fused silica cube and four completed reflectors. The three reflectors in the foreground show, left to right, the hexagonal face that will point toward Earth during the S-66 orbit, a side view of the reflector, and a back view. Also in this back view are the deposited aluminum reflecting surfaces and the triangular mounting surface.

ENGINEERS: Here are six good reasons fc investigating an aerospace career at General Dynamics | Astronautic



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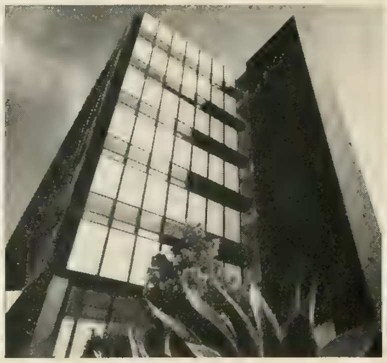

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man. Since its only constituent is silica, it is not made by melting and combining various constituents, as are most glasses. Corning manufactures fused silica by spraying a silicon-containing gas through a flame, resulting in deposit of tiny molecules of silica soot, which are built up into a usable article called a boule.

An indication of the radiation resistance of the material is its continued transparency after exposure to 10^9 roentgens of gamma radiation from cobalt-60. At 1.4 x 10^{10} roentgens, a slight bluish tint might appear.

Other properties: temperature coefficient of linear expansion, 5.5 x 10^{-7}/in./in./°C; short-time temperature capability, 1,100°C; long-term temperature capability, 900°C; specific gravity, 2.2; refractive index (0.5893 microns), 1.459.

The *S-66* corner reflectors would last 60 years in space before radiation darkening would degrade the glass beyond usefulness, according to a NASA official. Made by Boxton-Beel of Brooklyn, manufacturer of precision optics, the reflectors are polyhedrons with hexagonal pupils.

- **Making the reflectors**—Aluminum reflecting surfaces were deposited on the fused silica by vacuum evaporation, then coated with a protective film of silicon monoxide, says Robert B. Been, Boxton-Beel vice president.

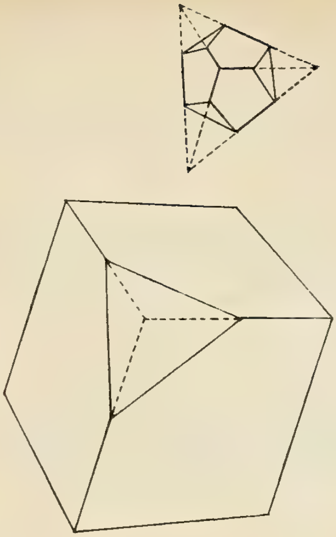
Each reflector contains three 90-degree angles, precise to one second of arc. Mirror surfaces are arranged to return the laser beam to the ground at the same angle it is received by the prism. The reflected beam will not miss the receiver, principally because of the width of the beam and the short time between transmission, reflection and reception of the laser pulse.

NASA says the output of the Wallops Island laser transmitter is a one-joule, 200-nanosecond pulse every second. Frequency will be 4.32 x 10^{14} cps (6,940 Angstrom unit wavelength). Transmitted beamwidth will be three minutes of arc, and effective transmitting antenna gain will be 70 db.

The reflected beam, contained in a one-second beamwidth equivalent to 90 db. gain, will be sufficiently wide to permit the transmitter and receiver to be mounted together. The receiver will be a tracking telescope system modified by replacement of the camera by an optical filter and photomultiplier.

- **Main experiments**—The chief objective of the *S-66* project is to conduct ionospheric measurements on a worldwide basis. These are expected to point the way for plotting the form and structure of the ionosphere and describing its behavior under varying conditions of solar radiation.

The secondary objective of the program is to learn the total electron count of a vertical cross-section of the ionosphere located between the satellite and Earth.



EACH REFLECTOR for the S-66 satellite is cut from a corner of a cube of fused silica. Three vertical cuts are then made to remove the tips of the pyramid-shaped corner, as shown in the smaller drawing. This second operation leaves the reflector lying face down on a flat hexagonal surface, which becomes the face of the finished reflector. The three pentagonal areas shown in the sketch become the reflecting surfaces. They are at right angles to each other because they form the original corner.

Accomplishing these objectives will establish several needed geophysics facts, including a possible correlation between the behavior pattern of the ionosphere and the fluctuations of solar radiation.

This information on ionospheric behavior is expected to contribute heavily to the scientific information needed for such important technical areas as communications and precision tracking. A better knowledge of the ionosphere mechanism, for instance, will permit more precise forecasts of ionospheric storms and disturbances, making it possible to lessen or circumvent their interference with transmissions.

The data will also supplement ground-station ionospheric data used to predict optimum communication frequencies, and will provide detailed upper ionospheric data, a requirement for precision tracking systems. ■

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Russians Discuss Space Radiation Findings at Conference

by **Heather David**

SOVIET SPACE SCIENTISTS apparently are putting extremely stiff limits on acceptable radiation dosages for their orbiting cosmonauts.

Brig. Gen. Don D. Flickinger (USAFMC Ret.), returning from talks with Soviet space physicians at the International Astronautical Federation Bioastronautics sessions in Rome, said the Soviets are looking at the radiation problem very closely and are not dismissing the possibility that solar flares may be acceptable risks. However, "they apparently do not want to expose the cosmonauts to any greater danger than (that existing in) terrestrial situations," he said. The present limits they set are about the same as those used in industry.

At present, the limit set by the Soviets is 25 rem for flights of several days to a year. The National Aeronautics and Space Administration's mission dose limit is 50 rem (for X- and gamma-rays), and lifetime limit is 250 rem. The Soviets said their limits may be changed after further acquisition of data on biological effects of individual components of cosmic radiation and with development of radioprotective drugs.

- **New drugs**—The Russians reported good results in developing several drugs for radiation protection. Scientists P. P. Saksonov, V. V. Antipov, V. S. Shashkov, B. L. Razgovorov, G. F. Murin and V. S. Morozov of the USSR Academy of Medical Sciences, said they injected a number of compounds into the peritoneum (abdominal lining) of mice for 15-30 minutes before irradiation.

These compounds were cystamine dichlorhydrate, dihydrobromide aminoethyl-isotiuronium (AET), serotonin-creatin-sulfate, 5-methoxytryptamine chlorhydrate, tryptamine chlorhydrate, and 5-oxytryptophan.

Test and control animals were then subjected to lethal doses of gamma rays and protons. Best protection was achieved with AET, 5-methoxytryptamine and serotonin. In these protected groups, 50-70% of the mice lived. Even those that did die had a considerably longer life than the unprotected mice, the scientists added. With cystamine, 50% lived, and with the remaining two compounds an additional 20% survived.

Although the papers did not say so, observers at the conference said the Russians claimed they had little or no side effects with these drugs. The occurrence of toxic side effects has plagued U.S. scientists in their search for radioprotective drugs (M/R, Sept. 26, 1960, p. 39).

Antipov also said that the cosmonauts were provided with special radioprotective compounds for use in the event of sudden increase of radiation.

- **Radiation prediction**—The Soviets also are making some attempt at predicting solar flares by setting up a "solar service" before, during and after flights. Astrophysical and heliophysical observatories all over the Soviet Union have conducted continuous optical, magnetic and radio observations of the Sun, they said. In addition, six or seven balloons were sent aloft from various points in Russia to gather radiation information in the upper atmosphere. Data from these were used to make flight decisions, they said.

- **Space laboratories**—The cosmonauts spent much time in space conducting experiments on such biological specimens as mice, fruit flies and seeds, to study radiation and weightlessness effects.

Experiments carried out by A. G. Nikolayev and P. R. Popovich with Drosophila melanogaster (fruit flies) proved that mating, egg-laying and normal development of flies is possible under weightlessness.

However, other cellular and spore level experiments evidenced some genetic changes. Popovich carried out a study of Transcandenia microspores some 56 hours after launch. These spores evidenced new "constructions"—spherical fragments in the material during metaphase, anaphase, telophase, prophase and interphase.

This type of experiment was repeated by V. F. Bykovsky at three different intervals during his flight, the results of which were not released. However, the Russians hinted that these may bear out the theory of change.

- **Cardiovascular effects**—The fifth Russian paper, which was not presented in the formal sessions, dealt in great detail with cardiovascular responses of the cosmonauts. In general, the measurements showed that the cardiovascular system adjusted well to weightlessness with no apparent deterioration. A sidelight of this paper was the evidence that the reactions of Valentina Tereshkova, the only woman in space, appeared to be more emotional than were those of the men. The Soviets made measurements with electrocardiography, phonocardiography, seismocardiography, sphygmography and arterial oscillography.

Gen. Flickinger added that the Russians said they had had no evidence of orthostatic hypotension, the circulatory condition which appeared slightly in Walter Schirra after recovery. He said that no mention was made of increased calcium mobilization (loss of calcium from bones) from weightlessness. Other U.S. doctors said that in earlier talks with the Soviets they reported some calcium mobilization in *Vostoks 3* and *4*. ■

RADIATION DOSAGES MEASURED IN SOVIET MANNED SPACEFLIGHTS

		TOTAL	PER 24 HOURS
Y. A. Gagarin	Vostok 1	< 1 mrad	7.2 mrad
G. S. Titov	Vostok 2	12 mrad	8.4 mrad
A. G. Nikolayev	Vostok 3	43±1 mrad	13±2 mrad*
P. R. Popovich	Vostok 4	32± mrad	13±2 mrad*

* Soviets attribute increased dosage to possible residual radiation caused by U.S. high-altitude nuclear explosiion on July 8, 1962.

Multiple Re-entry Vehicles Urged

San Diego, Calif.—Slender re-entry vehicles, steerable and multiple re-entry vehicles, decoys, precursor chaff-jamming of defense systems, and tactical space nuclear bursts figured in presentations at the 8th Symposium on Ballistic Missile and Space Technology, sponsored by the Air Force Space Systems Div. and Aerospace Corp.

Discussion of nuclear bursts touched on the vulnerability of manned orbital command posts, the effects of transient blast on re-entry vehicles and development of X-ray protection for them.

Appreciable advantages would come from using multiple re-entry vehicles, H. C. Sebring and S. Matlin, Missile and Space Div., General Electric Co., reported. Using a Monte Carlo computer model to simulate multiple re-entry vehicle ejection and target attack, they found that multiple re-entry vehicles can achieve high probabilities of large-area kill, even with low survival probabilities for individual vehicles.

An additional bonus revealed by the company-funded study is the much higher chance that at least one warhead will penetrate to the target.

The study also concluded that multiple re-entry vehicles with patterned aimpoints can give a point-target kill-probability exceeding that for a single weapon of maximum payload weight.

Six to 12 re-entry vehicles come out as the best number on the computer simulation for any combination of vehicle survival probabilities and target hardness. Only exception is for relatively soft (less than 50 psi) undefended point targets. Then one re-entry vehicle of maximum weight has a slight advantage for good delivery accuracies.

An excellent potential was seen for use of multiple re-entry vehicles to attack multiple targets. Booster, launching and logistics costs are lower than those of delivering a single re-entry vehicle per target. And costs are very high for reasonable multiple-target protection against multiple re-entry vehicles originating from a single booster.

Uncertainty about future enemy defense systems makes recommendation of decoy weights difficult, the GE spokesman said. He suggested that this is a good reason for developing a multiple re-entry vehicle system instead.

• **Telltale UV**—Detection of vehicles in mid-course, well before re-entry, by measurement of ultraviolet emission of rarified gas from the vehicle is under study for the Ballistic Systems Div., Air Force Systems Command, by Space Technology Laboratories. Leonard Glass of STL reported that an upward-viewing optical system flown above 30 km should be able to detect the equivalent of 4 cu. cm. (STP) of rarified fuel residuals around the vehicle.

Glass suggests flying the detecting system in a U2 aircraft or in high-altitude ballons. He notes that sensitivity of a satellite system with downward-looking detectors is limited by background radiation from the atmosphere. An upward-looking system, however, is limited only by electronic noise. ■

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SPACE DIVISION **CHRYSLER CORPORATION**

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Foamed Ceramic Insulation Possible

by John F. Judge

RESEARCHERS at United Technology Center are perfecting a new approach in foam ceramics—combining foam technology with chemical binding to avoid sintering.

The process involves mixing ceramic powder slurries with gas-forming agents and certain enzymes as catalysts—producing chemically bonded foam structures. Each crystal is separated by an adhesive so that the material is heterogenous, eliminating thermal shock problems in its applications.

The stable, lightweight foams will not degrade in high-temperature applications except by melting and vaporization. The material has a moderate structural strength.

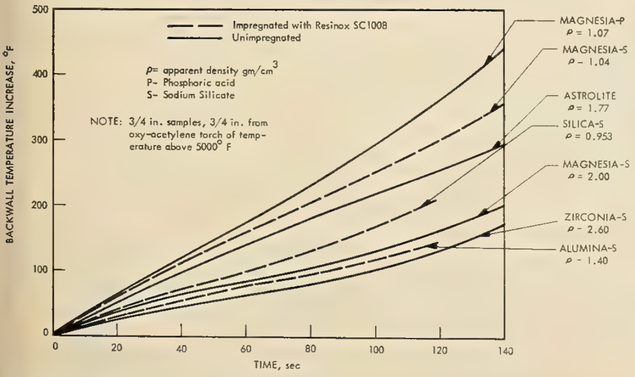
Brittleness is still a factor in the chemically bonded foams, but cracks do not propagate easily through such a microstructure. Pore size can be accurately controlled by varying the amount of gas-forming agent used. UTC experts can reach 90% theoretical density and specific gravity results as low as 0.8 g/cc.

The application of heat to such foamed ceramics decomposes the chemical binder, and the material then sinters. There is no deformation, just a gradual melting and vaporization of the affected surfaces, say UTC experts.

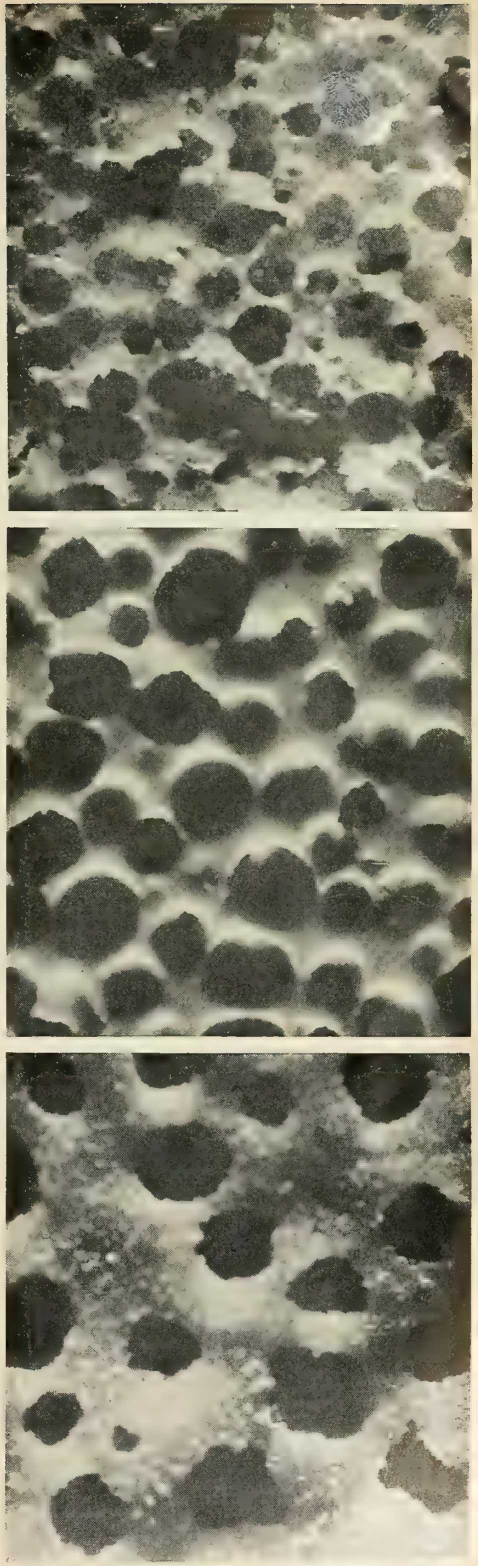
Foams of varying densities have been achieved with asbestos, silica, MgO, Al_2O_3 and zirconia with peroxide gas formers and either enzyme or other applicable catalysts. The chemical binders used include silicates, phosphates, phosphoric acid and oxychlorides.

The foams can be cast in molds and all are easily machined to final finishes. The process is air-dried.

The main applications in mind for the foamed ceramic systems are as insulators in rocket engines. In this use, the lack of high structural strength is not as important as the insulative ability of the materials. The foams would be used as a heat sink behind a tougher ablative. ■



TYPICAL THERMAL gradient curves for both impregnated and unimpregnated chemically bonded ceramic oxide structures.



TOP TO BOTTOM: UTC microphotographs show the foamed structures of chemically bonded silica, alumina and magnesia, respectively.

Heat treat this rocket case?
Not likely!

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New Firms and Divisions

Kaiser Aerospace & Electronics Corp. will begin operations Dec. 1 as a wholly-owned subsidiary of Kaiser Industries Corp. The new corporation will acquire the business and assets of Kaiser Aircraft & Electronics, currently an operating division of Kaiser Industries and a developer and manufacturer of solid-fueled rocket motor components, ground support equipment, and major profile-machined forgings for aircraft. Plants are located at Palo Alto, San Leandro and Richmond, Calif., and Phoenix, Ariz., with executive headquarters at Kaiser Center, Oakland, Calif. . . . *International Telephone and Telegraph Corp. has established an Astrionics Center at San Fernando, Calif., responsible for missile/space systems research and development. Nucleus of the new aerospace unit is the staff of the company's Astrionics laboratory formerly located at Fort Wayne, Ind. Approximately 50 scientists, engineers and technical support personnel were involved in the move. The center is concentrating on navigation, guidance, flight control, information return and tracking.*

Industry Facilities

North American Aviation's Columbus (Ohio) Div. has broken ground on a $1-million transonic-supersonic wind tunnel in support of its tactical missile activities. The facility will create wind velocities of 530 to 3,400 mph and will enable North American engineers to conduct airflow and related studies on a variety of tactical missile models. . . . *NEICO Microwave Co. has moved into a 8,000-sq.-ft. plant in Waltham, Mass. The move quadruples the firm's facilities. Commensurate additions are being made in personnel and equipment.* . . . Moxon Electronics Corp. Los Angeles, an instrumentation and systems sales engineering firm, has opened a standards, calibration and repair facility. Initial services offered include: precision instrument calibration, repair and overhaul. . . . *Aerolab Development Co., Monrovia, Calif., has moved to a 30,000-sq.-ft. plant, which will house engineering, production and administrative services formerly in three locations in Pasadena. Aerolab, a subsidiary of Marshall Industries, is a supplier of sounding rockets and space probes.*

International

Hughes Aircraft Co., Culver City, Calif., and Compagnie Francaise Thomsen-Houston, Paris, have formed a new company, Societe Europeene de Materiels Speciaux, as a joint venture. SEMS will direct its activities in the general areas of aerospace technology using electronic and infrared techniques as well as advanced communications systems. It will draw on advanced technologies of both parent organizations and will include research, development and manufacturing capabilities at its facilities in France. Ownership of the new company will be divided 51/49, with the French firm holding the majority interest. . . . *McPherson Instrument Corp., Acton, Mass., has appointed Nissho Co., Ltd., Tokyo, as sales and service representative for Japan for the company's line of spectrographic instruments.* . . . Telesco International Corp., New York City, has been named export representative for Communication Electronics, Inc., Bethesda, Md., manufacturers of special purpose radio receiving equipment. Telesco will handle sales activity and engineering liaison for CEI in all countries except Canada and the U.S. . . . *Computer Instruments Corp., Hempstead, N.Y., manufacturer of precision-film potentiometers, pressure transducers, recorders, switches and commutators for the aerospace industry, government and medicine, has appointed two new overseas manufacturers representatives, Ronald J. J. Payne Pty., Ltd., Richmond, Australia, and B. N. Bose & Co., Calcutta, India.* . . . Varian SpA, a subsidiary of Varian Associates, Palo Alto, Calif., has been established in Turin, Italy, to serve the company's expanding sales to the European Common Market. Varian SpA will be an engineering and manufacturing facility.

In the Courts

Atlantic Research Corp. Chief Executive Officer Arthur W. Sloan has reassured ARC stockholders that the company is in a good position to defend against two recent law suits filed by American Potash & Chemical Corp. (M/R, Oct. 14, p. 41) and Atomics, Physics & Science Fund, Inc. Sloan said ARC had anticipated such suits as a result of Security Exchange Commission proceedings last year, "which furnished a basis on which certain institutional investors in the company could attempt to recapture losses suffered in the decline of the market price of Atlantic Research stock, which commenced in the spring of 1962 after widespread publicity was given to the alleged over-pricing of (ARC) growth stocks."

Company Representatives

Wyco Metal Products, Los Angeles, has named Newman Sales Co., Carnegie, Pa., to represent the Wyco line of metal enclosures in West Virginia and part of Pennsylvania. Wyco products are used in electronics, communications and test equipment industries. . . . *Moran Hanson Associates, Inc., Fayetteville, N.Y., has been named upstate New York sales representative for Carter-Princeton, Princeton, N.J. C-P designs and manufactures thermoelectric equipment and circuitry.* . . . Compar Corp., San Francisco, has been appointed national sales representative and distributor for Felsenthal Instruments Co., Chicago. Compar will also serve as distributor for the Felsenthal Electronics Div., manufacturer of instruments panels for aircraft, communications and missile/space use.

M/R

missiles and rocket

Advanced Research, Technology and Development

Issue Date
November 25
1963

Advertising Closes
November 11
1963

Projects Gemini and Apollo are well under way. The Nationa Aeronautics and Space Administration is currently planning fu ture projects like the orbiting space station, lunar base, manne Mars expedition, unmanned exploration of the Sun and the dis tant planets, and detailed investigation of Earth's environmen

M/R's Third Annual National Aeronautics and Space Adminis tration issue will be a 100-page report covering advanced researc technology and development requirements for these program

hird annual NASA issue

This issue will include:

. Advanced Research and Technology

Spacecraft Structures ☐ Propulsion ☐ Nuclear Systems ☐ Electronics ☐ Biotechnology and Environmental Systems

2. Funding Requirements and Procurement Policy

NASA's in-house apportionment of the Fiscal Year 1964 Budget ☐ Effects of Congressional cuts in the budget ☐ Report on Fiscal Year 1965 Budget ☐ Budget Projection through 1975

3. Advanced Development Programs

Manned Spaceflight ☐ Unmanned Interplanetary Spacecraft ☐ Scientific Satellites ☐ Commercial Application Satellites ☐ Launch Vehicles after Saturn ☐ International Programs

4. NASA Field Centers

New facilities and equipment required at each installation by the advanced spacecraft and launch vehicles.

5. Directory of Key NASA Officials

Name ☐ Job Title ☐ Room and Telephone Numbers

JULY 1963 SURVEY OF NASA OFFICIALS IN THE MANNED SPACE FLIGHT PROGRAM

Business Papers Read	Percent Mentioned
Missiles and Rockets	64.9%
Aviation Week & Space Technology	43.3%
Aerospace Management	19.6%

SOURCE: M/R Research Department

5,000 Bonus Circulation to NASA Officials

Total NASA Circulation 6,500.

43,170 Regular ABC paid circulation.

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NASA will award many of the study and hardware development contracts for these projects by mid-1964. Advertise your products and capabilities in M/R's Third Annual NASA issue to reach your audience at this critical decision time.

Advertising Closes November 15

contracts

AIR FORCE

$5,000,000—**Ling-Temco-Vought, Inc.**, Dallas, for work on a classified program.

$2,500,000—**Jordan & Co.**, for construction of hardened antennas for *Minuteman* missile sites neary Cheyenne, Wyo.

$2,500,000—**Pan American World Airways**, New York City, for operation and maintenance of the Churchill Research Range, Fort Churchill, Manitoba.

$2,500,000—**Massachusetts Institute of Technology**, Cambridge, for continuation of research and development on properties of matter in intense magnetic fields.

$1,900,000—**Marquardt Corp.'s Pomona Div.**, Pomona, Calif., for development and production of eight *Atlas* crew procedure trainer systems.

$1,600,000—**F&M Systems Co.**, Dallas, for systems work on a solid-propellant rocket engine surveillance facility at Hill AFB, Utah.

$1,000,000—**Technical Operations, Inc.**, Burlington, Mass., for models for battle simulation.

$630,000—**United Aircraft Corp.'s Hamilton Standard Div.**, Windsor Locks, Conn., for design and fabrication of devices for in-process analysis of micro-circuits.

$298,500—**Columbia University**, New York City, for Project *Defender* anti-satellite studies.

$130,628—**Columbia University**, New York City, for hydromagnetic plasma research.

$74,710—**National Research Corp.**, Newton, Mass., for development of tantalum alloy base with strength nearing 3000°-3500° F range.

ARMY

$3,500,000—**General Precision, Inc., Kearfott Div.**, Little Falls, N.J., for additional quantities of *Pershing* missile hydraulic actuator systems.

$983,967—**Franchi Construction, Inc.**, Titusville, Fla., for alterations to *Mercury-Atlas* Complex 14 at Cape Canaveral.

$391,803—**Williams Development Co.**, Orlando, Fla., for construction of a radar boresight range on Merritt Island.

$334,128—**H. J. High Construction Co.**, Orlando, Fla., for phase-one construction on the Manned Spacecraft Center's parachute and paraglider building on Merritt Island.

$327,492—**The Regents of New Mexico State University**, University Park, N.M., for *Nike-Zeus* PRESS meteorological program including work on high-ball and speed-ball phases.

$61,652—**General Dynamics Corp., Pomona Div.**, Pomona, Calif., for redesign of GTV missile.

ITT Federal Laboratories, Nutley, N.J., for applied research in advanced space communication techniques.

NAVY

$3,600,000—**Sperry Rand Corp.'s Ford Instrument Co. Div.**, Long Island City, N.Y., for fire control computers for the *Tartar* missile.

$2,200,000—**North American Aviation, Inc., Autonetics Div.**, Anaheim, Calif., for *Polaris* sub navigation equipment (SINS).

$1,700,000—**U.S. Steel Corp.**, McKeesport, Pa., for *Bullpup* missile warheads.

$1,008,525—**Bendix Corp.**, Towson Md., for design and manufacture the tracking and computer system and performing systems integration in connection with a mobile all-weather missile-range safety system.

$1,000,000—**Westinghouse Electric Corp.**, Pittsburgh, Pa., for a launcher for the *Polaris* missile to be used by the British Royal Navy Polaris School in Scotland.

NASA

$2,000,000—**Motorola Military Electronics Div.**, Scottsdale, Ariz., for development and production of spaceborne data link equipmen to receive and assimilate information from control centers on Earth from the *Apollo* spacecraft.

$1,700,000—**Collins Radio Co.**, Dallas, for electronic and hydraulic system requirements fo the operation of an 85-ft. parabolic antenna

$1,300,000—**Hughes Aircraft Co.**, Culver City Calif., for launch and orbital control station plus station operation and maintenance of th Syncom spacecraft.

$479,730—**Chicago Bridge and Iron Co.**, Greenville, Pa., for construction of an altitud chamber facility.

$421,000—**Adler Electronics, Inc.**, New Rochelle N.Y., for mobile high frequency radio systems

$384,380—**Milgo Electronics Corp.**, Miami, Fla for services, materials for modifications an additions to Wallops Island, Va., radar dat system.

$245,000—**RCA Service Co.**, Camden, N.J. fo ultra-high-vacuum system.

$139,400—**Vacuum Barrier Corp.**, Woburn, Mass for a cryogenic refrigeration system.

$138,795—**KPT Manufacturing Co.**, Roseland N.J., for production of a man-carrying ro tation device.

$100,000—**Tamar Electronics, American Gyr Div.**, Los Angeles, for initial work on th guidance system of *Little Joe II*.

$100,000—**North American Aviation, Inc., Spac and Information Systems Div.**, Downey, Calif for design study for modifications to *Apoll* spacecraft.

$99,864—**Aerojet-General Corp.**, Azuza, Calif for thermal-strain analysis of spacecraft he shields.

$71,210—**Sanborn Co.**, Waltham, Mass., for ma netic tape recorders.

$67,715—**Vector Manufacturing Co., Inc.**, Sout hampton, Pa., for telemetry equipment.

$66,000—**Applied Physics Corp.**, Monrovia, Pa for a space vibrating capacitor electromete

INDUSTRY

$1,000,000—**Beckman Instruments, Inc., System Div.**, Fullerton, Calif., from **North America Aviation, Inc.**, for data acquisition equi ment to be used in the development of th *Apollo* space vehicle.

$700,000—**Applied Dynamics., Inc.**, Ann Arbo Mich., from the **Boeing Co.**, for a general pu pose analog computer system to be installe at Boeing Co.'s simulation center in Hunt ville, Ala.

$400,320—**Airtek Dynamics, Inc.**, Compto Calif., from **Martin-Denver,** for productio of gaseous helium storage tanks for t *Titan III* booster system transtage.

$203,000—**McCormick Selph Associates**, Holliste Calif., from **Martin-Denver,** for continu production of M-100 pressure cartridges f the *Titan II* and *Titan III* missile system.

$170,000—**Lear-Siegler, Inc., Instrument Di** Grand Rapids, Mich., from the **Boeing C** for design and development of a rate of clin indicator for the *X-20*.

$140,000—**Mark Systems, Inc.**, Santa Cla Calif., from **Atlantic Research Corp.**, f supplying the primary attitide measuring sy tem for the *Athena* re-entry program.

$112,000—**American Brake Shoe Co., Dynis Div.**, Cambridge, Mass., from the **Boeing C** for electronic transducers for use in the *X-* spacecraft.

$100,000—**Veeder-Root, Inc.**, Hartford, Con from the **Boeing Co.**, for an elapsed time dicator for the *X-20* spacecraft.

$100,000—**RdF Corp.**, Hudson, N.H., from **M tin-Denver**, for the design, development a manufacture of convective heat and therm radiation transducers to be used in the *Tit III* standard space launch system program.

$28,757—**Swedlow, Inc.**, Los Angeles, from **Ae jet-General Corp.**, for reinforced plastic rock nozzle extensions for the second stage of t Wing VI *Minuteman* missile.

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Here, a young, wide-awake management is moving ahead in practically every phase of rocket technology, creating sophisticated engines of ever increasing efficiency to meet specialized space and weapons mission requirements. One famous achievement is the turbo rocket engine powering the X-15 aerospace vehicle...another is the packaged-liquid engine now in quantity production for Navy and Air Force Bullpup missiles.

Backed by firm production contracts and the resources of Thiokol Chemical Corporation, with its many rocket facilities across the country, Reaction Motors Division today offers forward-looking engineers and scientists a challenging future in the van of tomorrow's advanced rocketry.

IMMEDIATE ASSIGNMENTS IN THESE AREAS:

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PROPULSION SYSTEMS. Preliminary design of advanced propulsion systems for spacecraft, weapons, ASW and new applications. Work closely with other depts. exchanging information and investigating new concepts. BSME, AE or ChE plus over 5 years experience in liquid fuel rocket propulsion systems.

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PROJECT ENGINEERING. Work on a variety of development problems in new rocket engine concepts, such as...systems design, size and weight, aerodynamics, etc. BSME, AE or ChE and 3 plus years experience in design and development of rockets, turbojet engines or flight-type components.

MATERIALS ENGINEERING. Creation of sophisticated plasma spray systems, improved nozzle inserts, etc. for application to new aerospace requirements. BS in Ceramic Engineering plus 5 years experience in development and application of very high temperature ceramic materials.

Address inquiries in confidence to Mr. Holden Rigby, Supervisor Professional Placement, Dept. 21

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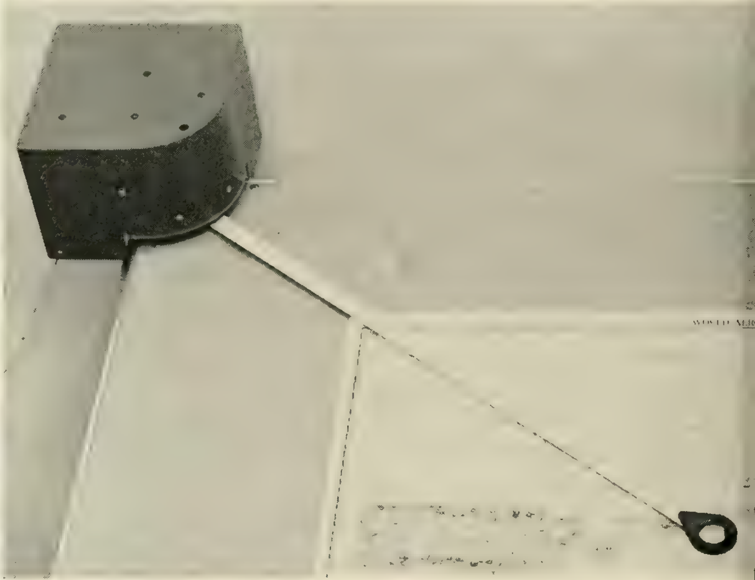
New Product of the Week:

Electronic Tracing Device



Temco Electronics Display Systems, Ling-Temco-Vought, Inc., has developed the Infotracer, an electronic tracing device for inserting graphic data into data processing and display systems.

Graphic data is transformed into suitable form by tracing contour lines of the source material with the Infotracer, which consists of a transducer head ar a control unit. Potentiometers with the device measure the displacement the head and transform data into X ar Y axes analog voltages.

Accuracies of ±0.15% of full sca and stabilities of ±0.02% are availabl The device has a 30 x 30-in. traci area.

Circle No. 225 on Subscriber Service Card

Tetrode

Raytheon Co.'s Industrial Components Div. has developed a 500-mc, 300-watt tetrode, with a dimension of less than 2½ in.

Designated CK8167/4CX300A, the metal-ceramic unit meets MIL-E-1 specifications. It is rated to withstand altitudes to 10,000 ft. and temperatures to 250°C. The tube passed performance tests of 18 blows at an impact acceleration of 50 g and a 30-minute vibration test with accelerations to 20 g.

Circle No. 226 on Subscriber Service Card

Wide-Band Video Amplifier

Conductron Corp. is marketing the Model C-300 Video Amplifier, a solid-state device with a flat response characteristic and less than ±0.5-db ripp ranging over 100 cycles to 105-m Voltage gain is 20 db nominal with input impedance of 50 ohms and output impedance of 100 ohms.

Output voltage is 8v, peak to pe Rise time is less than 5 nanosecon Power requirements are 20v at 220 n

Circle No. 227 on Subscriber Service Card

Band Reject Diplexer

Antenna Systems, Inc., has availa a band reject diplexer for the 755 985-mc frequency range. Tuning is complished by plungers with prec brated counter settings and tuning st for VSWR matching. Operating f quencies can be changed and reset 30 minutes without pressure loss.

The device offers second harmo

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ejection of 20 db and third harmonic ejection of 10 db. Pass band insertion oss is 0.35 db. Pass band VSWR equals .25:1.

Circle No. 228 on Subscriber Service Card

Magnetic Tape Cleaner

Cybetronics, Inc., has developed a nagnetic tape cleaner that safeguards nstrumentation data both during the nitial recording stage and subsequent layback.

The Model E-3 utilizes an all-mechanical dry cleaning process which renoves all dropout-causing particles rom magnetic tape.

The device operates by passing the ape over a tungsten carbide scraping lade that skims off the high spots or odules that adhere to tape surfaces. At the same time, it loosens particles f dirt and oxide that are lightly adered to the primary oxide surface. The ape is then passed through several viping stations where silicon-treated issue wipes away the loosened particles nd reduces the static charge on the nagnetic tape.

Circle No. 229 on Subscriber Service Card

Magavolter

Kay Electric Co. is marketing the Magavolter 955B, a solid-state transfer eference instrument designed to indi-

ate one-volt RMS at frequencies from kc to 1,000 mc.

A signal generator with a one-volt alibrated output may be used in conunction with attenuators to provide mplitudes above or below one volt, eferences to a true one-volt RMS.

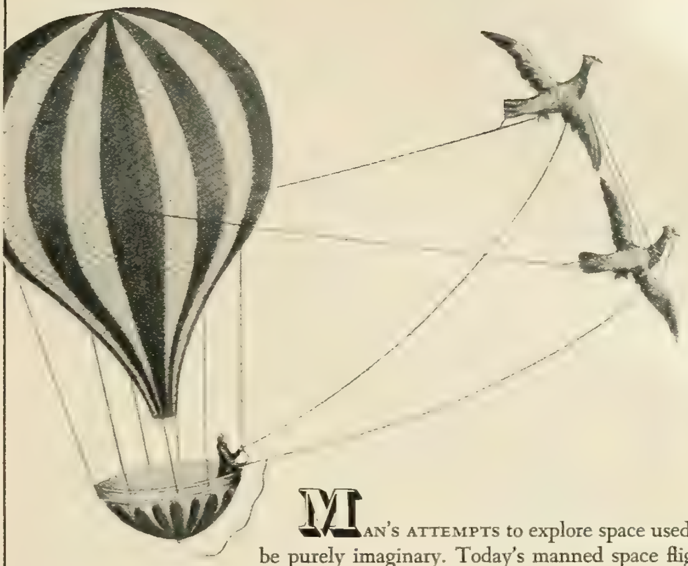
The unit has a VSWR of better than .1:1 over the entire frequency range. nput impedance is 50 ohms. Power upply is 2 Mallory RM42R batteries.

Circle No. 230 on Subscriber Service Card

hotoelectric Control

The Model RC-14 photoelectric conrol, for such use as full line shut-off, inpection and safeguard, is being maretеd by Photomation, Inc.

The device consists of a light source



EARLY 19TH-CENTURY SCIENTIFIC SUGGESTION FOR GUIDING A SPACE VEHICLE

MAN'S ATTEMPTS to explore space used to be purely imaginary. Today's manned space flight requires understanding of the physical and operational environments of space.

If *you* understand environments of space vehicles and your background includes: guidance/navigation, celestial mechanics, flight control, attitude control, or space data processing and communications, you are invited to investigate the many career opportunities available at IBM.

The IBM Space Guidance Center, as guidance system integrator for the Gemini program, is developing the Gemini computer as well as improved docking/retrieving and re-entry techniques for NASA. The Center is also developing the guidance computer and related equipment for the Saturn program. IBM's on-board data processor for the Orbiting Astronomical Observatory is further evidence of the professional level of accomplishment by our space technology scientists and engineers.

Current studies at the IBM Space Guidance Center—in central New York State, bordering on the Finger Lakes vacationland area—include re-entry guidance and control, and space station data management and communications. IBM is an Equal Opportunity Employer.

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and a photo unit that can be separated up to 10 ft. with standard red lens, and approximately 25 ft. with a clear lens.

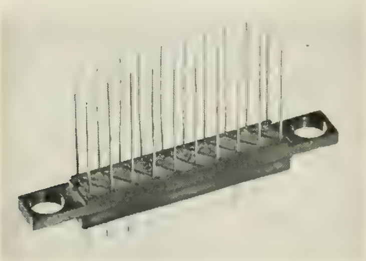
No amplification stage is required as the current through the photo cell operates the power relay coil directly.

Supply voltage is 115v ac. Consumption is approximately 7 watts. Relay contacts are rated at 10 amperes at 115v ac and 5 amperes at 230v ac noninductive current.

Circle No 231 on Subscriber Service Card

Module Connector

A connector developed for the *Apollo* program is being marketed by National Connector Corp. Called the



Model A-2128, the device is designed to eliminate the need for printed circuit boards.

Standard half-hard brass male contacts mate with regular female contacts on 0.2 in. centers. Circuit components are welded in "cordwood" fashion on nickel posts. The circuit package may be potted if desired.

The unit has 20 contacts and weld-posts of any desired length. Any desired contact configuration is available.

Circle No. 232 on Subscriber Service Card

Needle Valve

Dragon Engineering Co. is marketing the Model 100 needle valve, available in aluminum, brass or stainless steel.

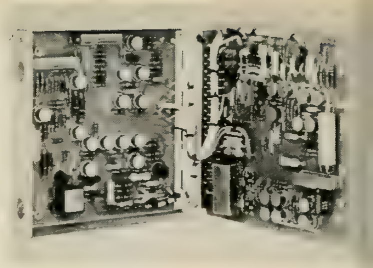
The unit is rated for 3,000-psi service with a 4:1 safety factor. Port connections are double male tube. The valve is available in ⅛ in. and ¼ in. sizes.

Circle No. 233 on Subscriber Service Card

Sample and Hold Units

Redcor Corp. is marketing two solid-state sample and hold units, Models 276 and 278.

Model 278 has a self-contained power supply; Model 276 requires external dc power. Specifications for both models include:



Gain: —1 minimum, —10 maximum; accuracy: ±0.02% input impedance: 100 k ohms for gain —1; outpu impedance 10 milliohms dc, 10 ohms 100kc; sample time: 10 μsec. minimum; hold time: 100 μsec maximum for 0.01% drift.

Circle No. 234 on Subscriber Service Card

Pressure Switch

A slide bar, wiper-type pressure switch measuring 0.6 in. in diameter has been introduced by Servonic Instruments, Inc.

The Model 2120 handles a current of 250 ma at 30v dc. Pressure range is from 0-500 to 0-10,000. Temperature range is —65° to 275°F. Static switch accuracy is better than 0.75% in one direction. Contact resistance i 2 ohms maximum. The unit can be reset within 1% of most ranges.

The switch is available as either gage or absolute pressure measuring device.

Circle No. 235 on Subscriber Service Card

UHF Isolator

A high power UHF isolator for us in missile/space tracking and communications equipment has been introduced by Special Microwave Device Operation of Raytheon Co.

Called the Model IUH12, the devic operates at 400 to 450 megacycles. I handles 10 kw average power and 1 megawatts peak power. VSWR is les than 1.10 in and out. High power isolation is 12 db minimum. Insertion los does not exceed 0.6 db.

Circle No. 236 on Subscriber Service Card

High-Vacuum Baffles

Consolidated Vacuum Corp. i marketing 4-in. and 6-in. nominal siz high-vacuum baffles, designed for us with liquid nitrogen as a refrigerant.

Designated the BCN series, the unit consist of a flanged housing with chevron element and reservoir assembly. Capacity of the reservoir provide a minimum operating period of 1 hours. A vacuum jacket surrounds th

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reservoir to reduce refrigerant losses to minimal.

Flanges of the aluminum casing have standard 150-lb. ASA series drillings and a raised gasket-seating surface designed for use with conventional O-rings.

Nitrogen level sensors and fillers are available with the unit.

Circle No. 237 on Subscriber Service Card

Tape Transport

S-I Electronics, Inc., has available the Model DX-01, a tape transport designed for airborne and all vehicular applications.

The unit reads pre-recorded computer tapes at a rate of 4 blocks per second. Transport speed is 15 IPS, adjustable ±30%, with a forward and rewind time of 1½ minutes for 2,400 ft. of tape. The magnetic head has seven tracks. Operating temperature range is 0° to 240°C at 15,000 ft. Humidity range is from 0 to 95% R.H.

Circle No. 238 on Subscriber Service Card

Galvanometer Amp

Geotechnical Corp. has available the Model 12613 galvanometer-phototube amplifier, designed for the 0.01 to 10 cps range. Noise level referred to input is less than 0.01 microvolt RMS. Plug-in circuit boards provide output interchangeability.

FM system gain is 700k. Center frequency is 1,550 ±25 cps with 500 to ,500 cps bandwidth. Sensitivity is 12 cycles per microvolt. Dynamic range is 0 db minimum; linearity is ±2% from noise level to greater than 75% of clipping level. Power required is less than ¼ watts.

Analog configuration sensitivity is 70v/radian. Gain is 350k and drift is less than 0.1 microvolt/4 hours. Dynamic range is 60 db minimum, and linearity is ±2% from noise level to 75% of clipping level. Power required is less than 2 watts.

Operating range is −60 to 125°F; humidity is 0 to 95%.

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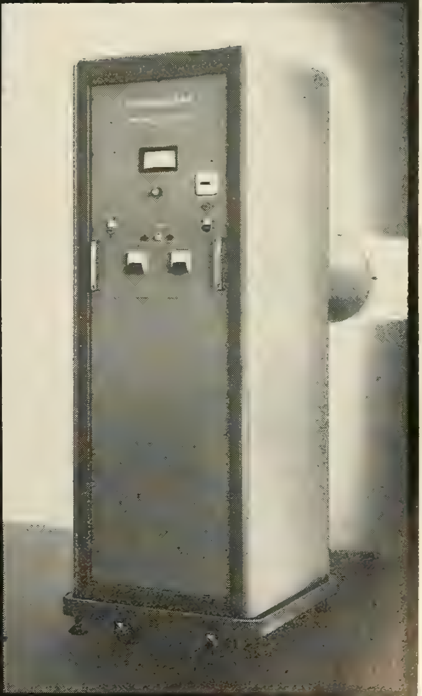
Copies of a comprehensive paper on solar simulation, "REACHING FOR THE SUN," by A. E. Mann, President of Spectrolab, are available upon request.



For complete data and prices, please contact:

spectrolab
DIVISION OF TEXTRON ELECTRONICS, INC.
12484 GLADSTONE AVENUE SYLMAR, CALIFORNIA
Telephone: [AREA CODE 213] 365-4623

Circle No. 13 on Subscriber Service Card

names in the news

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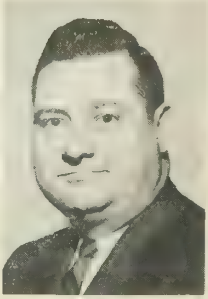
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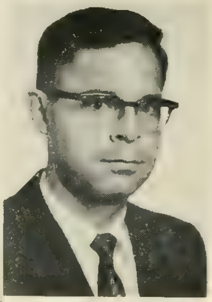
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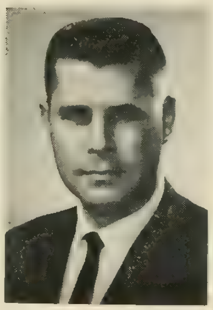
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Robert James Hanville: Appointed director of research and engineering for the Aerospace Div. of Walter Kidde & Co., Inc., Belleville, N.J.

R. Edward Platt: Appointed head of the public relations and advertising division of Dyna-Therm Chemical Corp., Beverly Hills, Calif.

M. C. (Bud) Baird: Named manager of marketing for F&M Systems Co., Dallas.

Stephen D. Moxley, Jr.: Appointed engineering manager of Avco Corp.'s Electronics Div. facility at Huntsville, Ala.

Donald J. McCandlish: Named director of marketing for the Transducer Div. of Consolidated Electrodynamics Corp., Monrovia, Calif.

George W. Dress: Joined Aerospace Industries Association of America, Inc., Washington, D.C., as assistant director-product support, industry planning support.

Nick Milakovich: Named director of manufacturing for Lockheed Missiles and Space Co., Sunnyvale, Calif.

Major Robert F. Windisch (USA Ret.): Named contract administrator for Therm-Air Manufacturing Co., Inc., York, Pa.

Samuel R. Porter named regional Florid sales representative for Therm-Air and fc the Redmanson Corp. (wholly-owned sul sidiary), York, Pa.

Paul Schiffres: Appointed a senior m crowave staff engineer of Paradynamic Inc., Huntington Station, N.Y.

Walter Williams: Appointed vice pres dent of the Thermal Space Div. of Dyna Therm Chemical Corp., Beverly Hill Calif.

F. J. Van Poppelen, Jr.: Appointed vi president and general manager of Signeti Corp., Sunnyvale, Calif.

Dr. Herbert Tramposch: Appointe head of the physics and applied mechani section, Engineering Directorate, for th General Engineering Div. of America Machine and Foundry Co.'s Advance Products Group, Stamford, Conn.

Irving Backinoff: Appointed vice pres dent and elected to the board of directo of Dranetz Engineering Laboratories, Inc Plainfield, N.J.

James H. McGarry: Appointed vi president-manufacturing for ITT Feder Laboratories, Nutley, N.J.

Stanley A. Hirsch: Named senior micr wave engineer of Paradynamics, In Huntington Station, N.Y.

John D. Movius: Appointed senior eas ern region representative for Northr Space Laboratories, Washington, D.C.

Lee Hachey: Named manager, quali assurance and reliability for Packard B Computer, Los Angeles.

Charles W. Stephens: Named manag of the newly formed Optics Div. at Electr Optical Systems, Inc., Pasadena, Calif.

Leonard S. Lyne: Appointed gene manager of D. B. Milliken Co., Arcad Calif.

Robert M. Pickard: Elected senior vi president of Cosmodyne Corp., Hawthor Calif. **Ross M. Brown** named vice pre dent-engineering and **William C. Gardı** named vice president-manufacturing.

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OCTOBER

Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, IEEE, Emerson Hotel, Baltimore, Oct. 21-23.

American Society for Metals, Annual Meeting and National Metals/Materials Show and Exposition, Public Auditorium, Cleveland, Oct. 21-25.

23rd National Convention, Society for Nondestructive Testing, Pick-Carter Hotel, Cleveland, Oct. 21-25.

Ninth Conference on the Design of Experiments in Army Research, Development and Testing, Redstone Arsenal, Huntsville, Ala., Oct. 23-25 (by invitation only).

Human Factors Society Annual Meeting, Ricky's Hyatt House, Palo Alto, Calif., Oct. 23-25.

Optical Society of America Annual Meeting, Sherman House, Chicago, Oct. 23-25.

National Electronics Conference, McCormick Place, Chicago, Oct. 28-30.

13th Annual Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 28-29.

Western States Section of the Combustion Institute Fall Meeting, University of Southern California, Los Angeles, Oct. 28-29.

IRE-PTGNS International Symposium on Plasma Phenomena and Measurement, El Cortez Hotel, San Diego, Oct. 29-Nov. 1.

IEEE 1963 Electron Devices Meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 1.

NOVEMBER

AIAA Vehicle Design and Propulsion Conference, Air Force Systems Command, Wright-Patterson Air Force Base, Dayton, Ohio, Nov. 4-6 (classified).

IEEE Northeast Electronics Research and Engineering Meeting (NEREM), Commonwealth Armory/Somerset Hotel, Boston, Nov. 4-6.

Society for Experimental Stress Analysis Annual Meeting and Exposition, Statler Hilton Hotel, Boston, Nov. 6-8.

ASME/AIAA/SAE/ASQC Joint Technical Conference, Disneyland Hotel, Anaheim, Calif., Nov. 7-8.

Magnetism and Magnetic Materials Conference, sponsored by AIEE, IRE and AIP, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., Nov. 11-15.

Seventh Annual NMR-EPR Workshop, sponsored by Varian Associates, Palo Alto, Calif., Nov. 11-15.

Fall Joint Computer Conference, sponsored by IRE, AIEE, Association for Computing Machinery and American Federation of Information Processing Societies, Las Vegas Convention Center, Las Vegas, Nov. 12-14.

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Navy Again Outgunned

THE ABRUPT but not surprising resignation of Secretary of Navy Fred Korth marks another victory in the Administration's continuing struggle to impose the authority of the Dept. of Defense on the three military services.

It is true that the conflict-of-interest charges in the TFX controversy may have had something to do with Mr. Korth's departure. But it is equally true that the Navy has been locked in a losing struggle with the Administration almost from the day President Kennedy took office.

Battle was joined with Adm. Arleigh Burke before the Inauguration Day snow melted from the Capitol steps. Soon after Adm. Burke's departure, the Administration and its Dept. of Defense team discovered that his successor as Chief of Naval Operations, Adm. George Anderson, was an equally undesirable character. Adm. Anderson fired a few parting shots from a National Press Club bunker and then beat a retreat to the ambassadorship in Portugal.

The CNO ship presumably now is in safer hands.

The Administration also will enter the next round with the Secretary's post in far friendlier hands—not only is Mr. Paul H. Nitze a Harvard man, but he is without question a whole-hearted supporter of Secretary of Defense Robert McNamara.

Before further analysis of Mr. Nitze's arrival, perhaps it would be well to review just what DOD has to say about the job of a service secretary. Under the McNamara regime, a service secretary no longer is a decision-maker in establishment of major policy in regard to weapon systems, budget and procurement. He is, instead, a manager and advocate of service requirements.

Top DOD staff officials like to describe the job of a service secretary as "head of a division in the DOD corporation."

The management responsibility is not to be taken lightly. Each of the service secretaries heads a department which spends from two to four times more in a year than the entire National Aeronautics and Space Administration. Complementary to the function as manager is that of chief budget officer for the department.

But it is the third of a service secretary's three major functions that perhaps is the most vital to the future health and well-being of the nation. The secretary serves as advocate for his service in the councils of the Dept. of Defense. He holds the responsibility for submitting programs to DOD which meet the military requirements of his service.

The secretary is the official who must carry the fight for service programs to the front office. If a program is rejected by DOD officials, the secretary can appeal to Mr. McNamara. If it is rejected by Mr. McNamara and if the secretary feels strongly enough, he can appeal the Defense Secretary's decision to the White House.

This is not merely a nominal right; it has been exercised on several occasions in this Administration.

The question that is depressing officers of the Navy today is this:

"What chance have you when your ball-carrier is on the payroll of the other team?"

For Mr. Nitze is one of the fair-haired boys of Mr. McNamara and the Administration. He helped former President Truman draw up the Marshall Plan and served as policy planning director for the State Department. He resigned from the Eisenhower Administration to run a school for international affairs.

He was brought back into government service by President Kennedy, who, even before his inauguration, had named Mr. Nitze to make a tactical weapons survey. When the new Administration took office, the former investment banker became Asst. Secretary of Defense for International Security Affairs, a largely political office.

Mr. Nitze was on hand, for example, in Nassau when Prime Minister Macmillan agreed with President Kennedy that *Skybolt* should be scrapped.

IT IS NOT SURPRISING that the Navy—which faces the loss of the Pacific Missile Range to the Air Force, which has seen its nuclear aircraft carrier program scuttled, which has had the value of its surface fleet openly questioned by the Secretary of Defense, which has seen its Afro-Indian responsibility shifted to the Strike Command—should wonder if Mr. Nitze is just the man to protect its interests against what it regards as the encroachments of DOD. Certainly, it is fair to predict that Mr. Nitze will be more likely to follow the line of McNamara policy than Navy policy when there is a difference with the uniformed warriors of his service.

That, of course, is not a drawback in the eyes of the McNamara team. It is seeking to eliminate just such conflicts in the DOD organization. Advocates of the McNamara line also are quick to point out that this does not represent any trend to a further centralization of combat operations, since the service secretaries are in the support structure, not the combat organization.

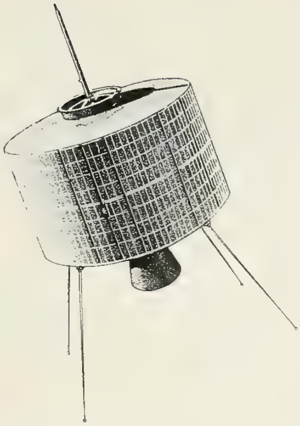
But there is little doubt that in Army Secretary Cyrus Vance and in the new Navy secretary, Mr. McNamara has two hand-picked supporters.

Veteran Pentagon reporters view these appointments as a move to reduce the status of the service secretaries to something that might more appropriately be described as "assistant secretaries of defense for the Army, Navy and Air Force".

This is a quite valid analysis—but there is a considerable difference of opinion between DOD and the individual services as to whether it is a desirable development. Only time will tell.

But one interesting aspect of all this is that it leaves able and outspoken Air Force Secretary Eugene Zuckert as the only service secretary among the original Kennedy appointees who is still in office.

William J. Coughlin



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Apollo: North American Aviation, Inc. Titan III: United Technology Center.

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ER 28, 1963

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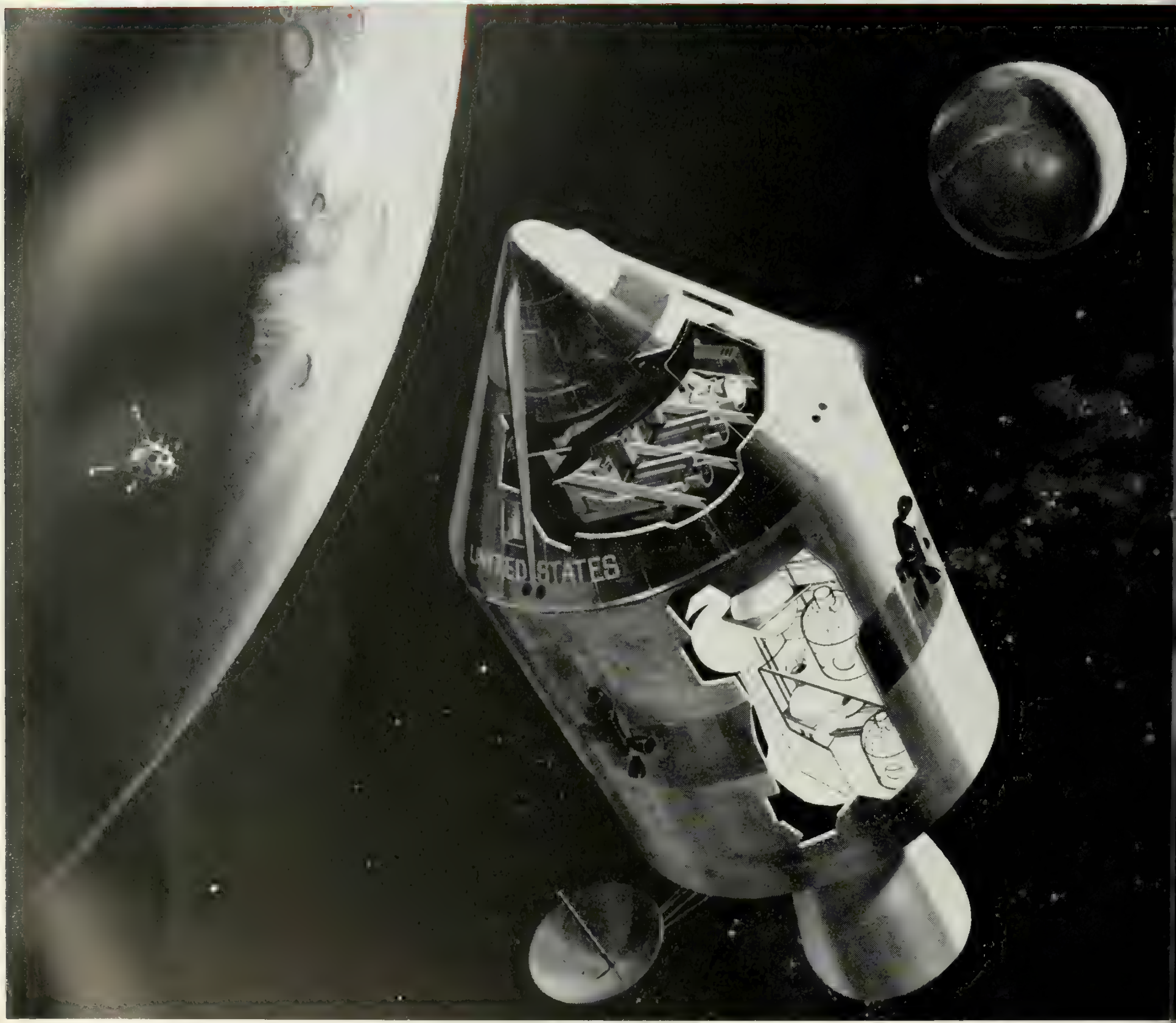

Shirtsleeves environment in space: Beech's job for NASA's Project Apol

Beech selected to develop and build Cryogenic Storage Subsystem for life support and electrical power

When American Astronauts embark on their upcoming journey to the moon, they can doff their spacesuits and travel in a comfortable "shirtsleeves" atmosphere. Responsibility for the design, development, manufacture and testing of the storage systems to provide that atmosphere has been given to Beech by North American. The same systems will also supply the gases to generate power for the command module.

The selection of Beech for this vital task is based on solid accomplishment and proven reliabil pioneer in Cryogenics, Beech has been active design, development, manufacture and test systems and sub-systems for many of our rock missile programs.

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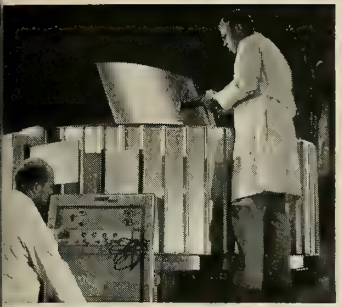

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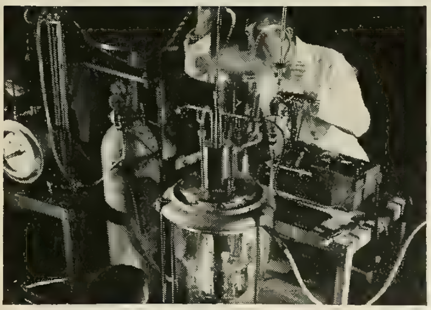

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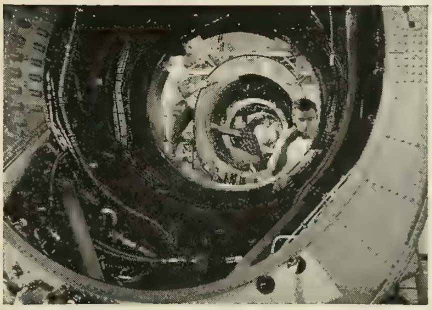

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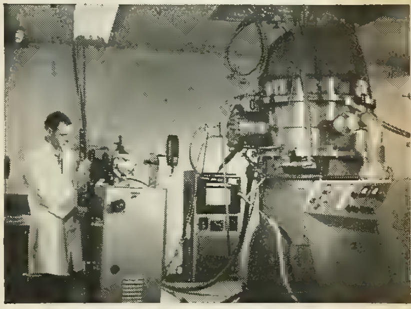
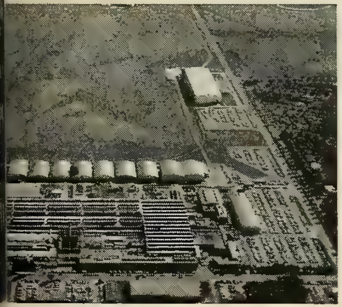


Space Simulation . . .



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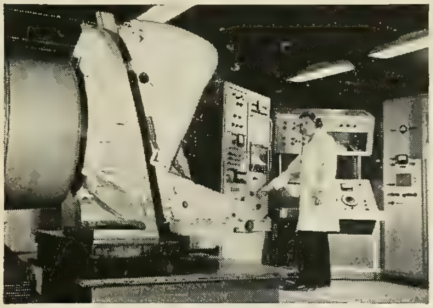

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The "Leviathan" project is part of our continuing simulation of large organizations. Currently in our Systems Simulation Research Laboratory we are staging the environment and data base typical of a highly structured intelligence center, where unexpected political events in a mythical Mediterranean region are presented to a 24-man team. Communicating by means of audio-visual equipment, the human subjects analyze all aspects of a tense situation. Decisions are made. Action is taken. The sense of personal involvement becomes most intense. Scientists observe the dynamic human interplay and decision-making processes. A large computer acts as fact finder, umpire, and scorekeeper. To scientists and engineers of SDC, Leviathan offers a continuing opportunity to study man-to-man and man-to-machine interaction, as well as to make objective evaluations of the communicating equipment itself. Leviathan in particular and simulation in general are but one phase of SDC's broad interest in information-systems technology. As newly learned knowledge helps to shape the systems of tomorrow, today's opportunities at SDC become ever more interesting and numerous. Human factors scientists, operations research scientists, systems-oriented engineers and computer programmers who believe their ultimate futures lie with this important and rapidly expanding technology are invited to write Mr. A. J. Granville, Jr., SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica, California; Washington, D.C.; Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An Equal Opportunity Employer."

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 18

October 28, 1963

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THE COVER

Mockup of Army's Ling-Temco-Vought Lance missile was publicly displayed for first time last week at the convention of the Association of the U.S. Army in Washington, D.C. The Army also released some new details on the weapon system. See p. 18.

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† U.S. Reg. Pdg.

DataTape
DataTape VP 3100
CEC

Smooth working team

Both have an eye on the budget

CEC's VR-2800 (general lab) and VR-3300 (portable) form an efficient team within CEC's complete and advanced line of recorder/reproducers. They are comparable solid state systems having interchangeable plug-in electronics, delivering high quality performance at relatively low cost. They can be used to complement one another in many applications.

Both instruments record 100 kc data at one-half conventional speeds. Thus, recording time of a single reel is doubled. They are currently serving on many critical military, lab, shipboard and van assignments.

Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0 to 20 kc with wideband FM techniques. IRIG PDM electronics are also offered.

Single cabinets of the VR-2800 and VR-3300 contain full 14-channel record and reproduce systems. Six standard speeds in three pairs (60, 30 ips; 15, 7½ ips; and 3¾, 1⅞ ips) are set by means of a simple belt and switch change. Both systems feature solid state electronics for reliability and low power consumption.

Other features include: all-metal-surfac magnetic heads, automatic end-of-reel sto and backlighted mode controls.

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letters

A Joint Moon Base

To the Editor:

I liked your Oct. 14 editorial, "A Lunar Proposal."

As you point out, we are quite well along with the design of hardware for the space program. We also know the Soviets are as well advanced and probably farther along than we are. As a matter of fact, I suspect that the Soviets may have a try for a Moon landing in 1964 and could be fairly sure of reaching it by 1965 if their calculations are at all correct.

Therefore, I do not believe there is too much chance of the Soviets turning over to us all their information on the design and construction of their space vehicles. And I doubt if we are in a position to do very much ourselves with the present mood that exists in Congress. As a result, the one spot where we might work with them is in exploration on the Moon, once it has been reached and men successfully landed.

I am going to call your editorial to the attention of the people in the space agency, although I am sure they probably read it before I did.

Clinton P. Anderson
United States Senate
Committee on Aeronautical
and Space Sciences
Washington, D.C.

To the Editor:

I think there is real potential and much good sense in your proposal for joint endeavor in a lunar scientific base. This should be an activity in which both participation and funding could be shared.

E. C. Welsh
Executive Secretary
National Aeronautics
and Space Council
Washington, D.C.

To the Editor:

It sounds like a good proposal, but I would need more time to think about the matter of establishing a scientific lunar base of such proportions—with or without the Soviets.

Joseph E. Karth
4th District, Minnesota
House of Representatives
Committee on Science
and Astronautics
Washington, D.C.

Angular Momentum (concl.)

To the Editor:

The writer was both surprised and sorry to see "Newton Revisited" in the Oct. 14 letters column.

Since this first letter, the National Academy of Sciences wrote again advising that they misinformed me and angular momentum is mass × radius squared × angular velocity.

Because of all the confusion I decided to try and discover who actually conducted the experiment to verify the equation. So far I have found no one who had actually verified this equation for a mass attached to a cord and revolved in a horizontal circle. The equation has been verified by Kepler, Newton and numerous others for planets in the universe. A little *deep* thought will convince you there is just no similarity between the tension on a cord from a mass revolving at constant gravity and the force of gravity which varies as the inverse square of the separation for planets in the universe.

So far, all attempts, to my knowledge, to verify the equation still indicate mass × radius × angular velocity is correct.

Any reader who has knowledge of the verification of this equation as normally given with the radius squared, by actual experiment, could do a great service to the advancement of science by so advising. Actually we have been using friction as an excuse for keeping the squared term, but an equation must describe what actually occurs—otherwise it is wrong and must be discarded. Friction can be made so low, and allowed for and calculated for so easily, it couldn't possibly cause this large an error.

John W. Ecklin
Huntsville, Ala.

To the Editor:

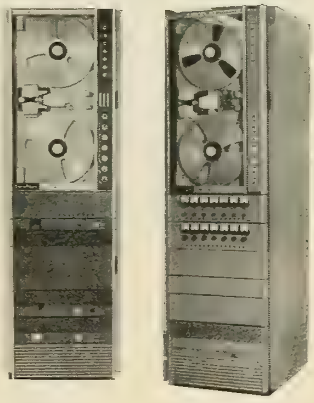
REF: "Newton Revised" letter, M/R, Oct. 14.

It is disquieting to see evidence of ready willingness to perfunctorily dismiss such an established and basic concept as that of angular momentum as derived from Newton's laws. But it is hardly conceivable that support for such misguided thinking should come from such a learned body as the "National Academy of Sciences–National Research Council, and signed by an executive officer." Certainly it is a well established fact, from classical analysis and completely confirmed by empirical data and experience, that angular momentum of a particle moving at constant velocity in a circle expressed as the product of its mass × *square* of its radius × its angular velocity is a property which is conserved in the absence of external torques. And this indeed *does* mean that if an internal mechanism were provided to reduce this radius to half, the angular velocity will be *quadrupled,* not doubled. Such a system must supply *energy,* but not torque impulse, thus accounting for increased kinetic energy, but conserving angular momentum. The tangential increase in velocity can be neatly derived from the good old theory provided us by Mr. Coriolis. So, please let's not be so ready to revise our textbooks, at least not without paying due homage to our eggheads of yesteryear.

Clare E. Barkalow
Manager, Advance Engineering Div.
Lear Siegler, Inc., Instrument Div.
Grand Rapids, Mich.

TWO MORE WAYS

CEC reflects the state-of-the-art in instrumentation record/reproduce magnetic tape systems



VR-2600 VR-3600

For extra wide bandwidth, consider CEC's VR-2600 with 7- or 14-channels. Handles precision data from 400 cps to 600 kc, Direct; d-c to 80 kc, FM; IRIG PDM and PCM at 1000 bits/inch on each of 16 parallel tracks via saturation techniques.

CEC's VR-3600 is the first 1.5 mc recorder sold to working specifications. Has linear phase vs. frequency characteristics, 7- or 14-channels, six pushbutton selectable tape speeds. Call or write CEC for Bulletins 2600-X30 and 3600-X22.

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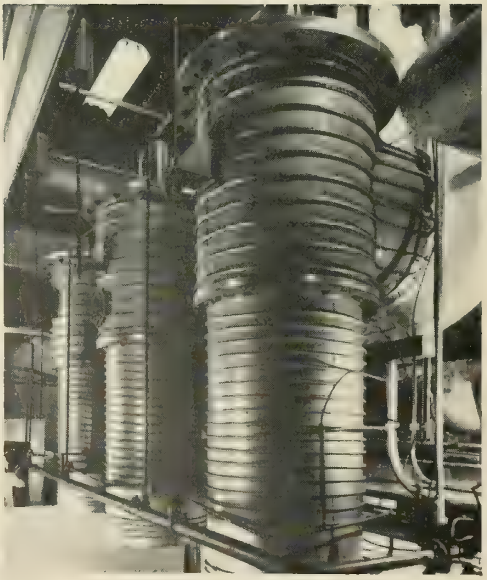
News Briefs



Silicones help simulate space . . .

Fairchild Camera and Instrument Cor poration's Defense Products Divisior has a 3,000 cubic foot test chamber a Syosset, Long Island. It is used to simu late the environmental pressure at alti tudes of 380 miles . . . vacua in th range of 4×10^{-9} mm Hg.

Dow Corning® diffusion pump fluid i used in the six 32-inch diffusion pump to achieve the desired test chambe pressure level. Silicone diffusion pum fluid offers superior resistance to oxi dation; will not decompose or los pumping properties; recovers 15 to 2 times faster than conventional fluid after exposure to air; eliminates th need to cool pumps before releasin vacuum; is chemically inert.

Dow Corning also produces a line c coolants for space chambers and othe test facilities. Some resist radiation.

CIRCLE No. 22 ON READER SERVICE CARD

AEROSPACE NEWS from Dow Corning

New silicone ablative material bonds in place... is lightweight... flexible

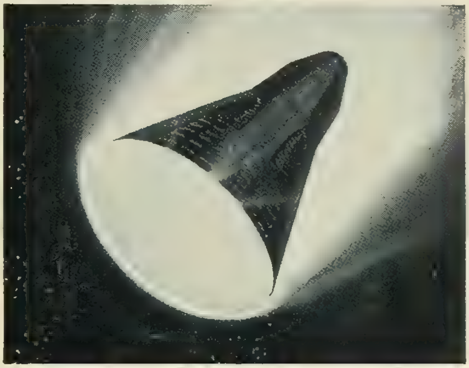
DOW CORNING® 325 Ablative Material has been selected by McDonnell Aircraft Corporation for the heat shield on NASA's Gemini spacecraft. There are numerous reasons, including:

Lightweight — for equivalent volume it weighs about one half as much as rigid reinforced plastics used for ablative applications.

Flexible — supplied as a pourable liquid, Dow Corning 325 ablative material can be cast or molded . . . cures to a rubbery solid. Thermally induced stresses which tend to destroy rigid materials are absorbed by the elasticity of this new material.

Bonds — Dow Corning 325 ablative material will bond to many metals, plastics and ceramics . . . has excellent sheer strength. Cured pieces can be bonded to substrates with adhesives. New Dow Corning 325 ablative material will bond to already cured sections of the same material, and to most materials used for honeycomb.

Swells — when exposed to heat fluxes that cause it to char, Dow Corning 325 ablative material swells, thus increasing the effective thickness of the shield.



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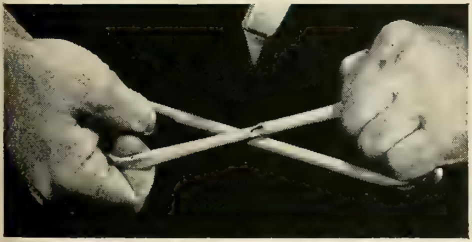

High strength, tear resistant silicone rubber . . .

Silastic® 950U rubber is a silicone stock designed for applications in aircraft, space vehicles and ground support equipment. This 50-durometer silicone rubber provides high tensile strength, 1400 psi minimum; tear strength of 175 psi or better; a brittle point of —178 F; good heat stability at 500 F. This stock shows all the properties typical of silicone rubber and is designed to meet the requirements of the following military and commercial specifications: MIL-R-5847D, Class III, Grade 50; MIL-STD 417, TA 510 and TA 512; AMS 3345; and SAE-ASTM TA 510 and TA 512. Parts made from this material are available from many companies fabricating rubber parts to meet the specialized requirements of aerospace applications.

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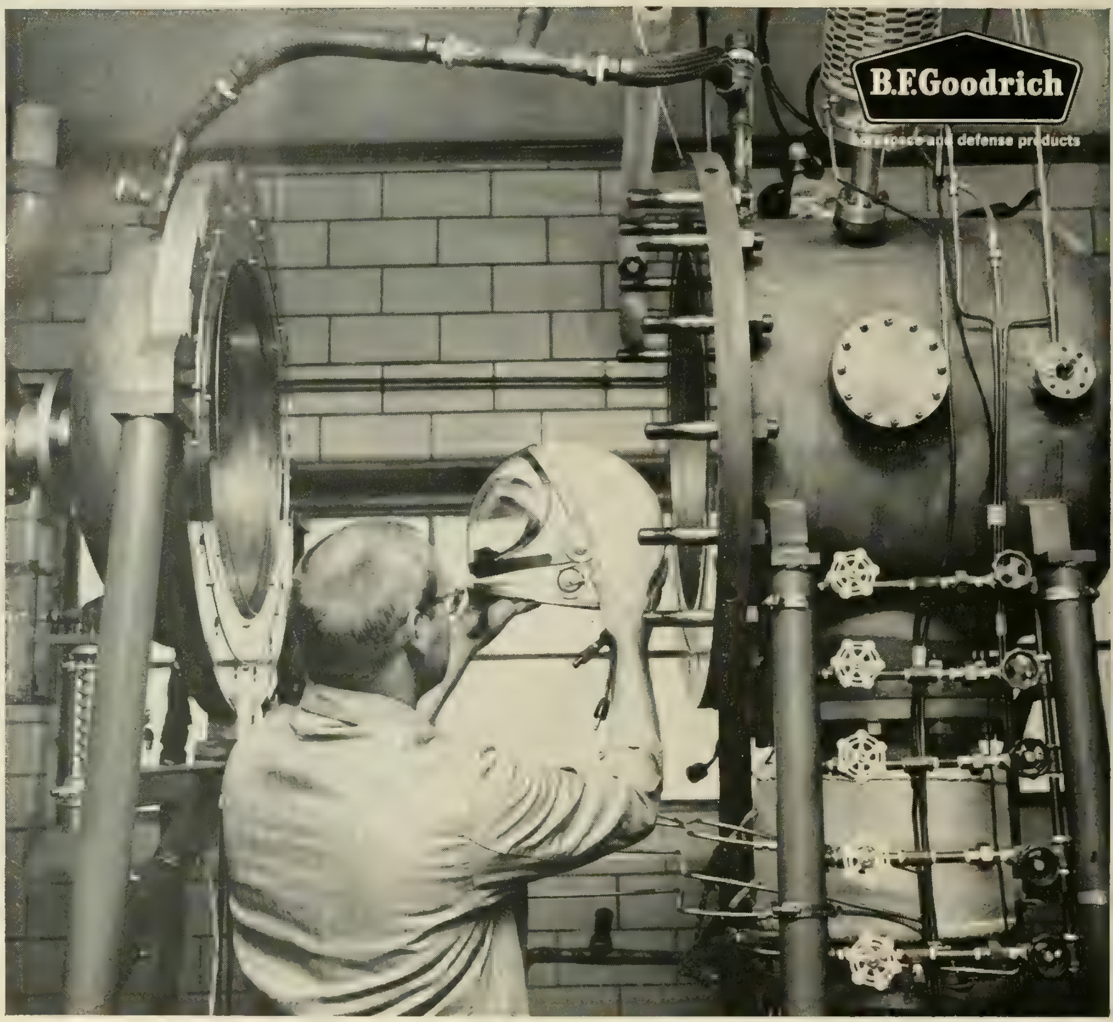
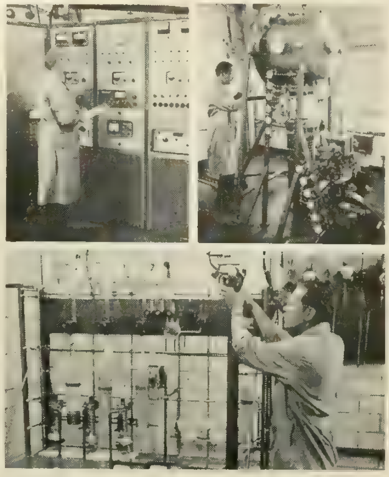
For further information about materials mentioned here . . . or our capability to provide you with tailor-made materials designed specifically to meet your requirements, write Dept. 6234, or call Aerospace Materials Department, Dow Corning, Midland, Mich.

Dow Corning



We simulate space...before we put a man in it



This environmental chamber at the B.F.Goodrich Research Center is believed to be the most *thorough* space simulator ever built.

In it, samples of materials and complete products are subjected to pressures ranging from atmospheric to those at 300 mile altitudes; to temperatures from 200°C below freezing to 200°C above freezing; to the radiation of the sun—visible light, ultraviolet, infrared, and X-rays; and to electrified atmospheres in which oxygen, nitrogen and the rare gases are highly charged and have high energies.

Similar testing proved its worth in the Project Mercury space suit program, resulting in better, more reliable materials.

The new simulator will be used to evaluate a wide range of physical, thermal, and electrical properties of different materials in a space environment. It will help develop better products for space flight. For complete information on use of this facility, write *B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Dept. MR-10, Akron, Ohio.*

Circle No. 3 on Subscriber Service Card

The Countdown

WASHINGTON

TOW, Shillelagh Competition Re-Opened

Army has initiated a new study seeking to determine whether the Aeronutronic *Shillelagh* antitank missile designed for the Sheridan armored vehicle can also fill the infantry role now assigned to the Hughes antitank *TOW* missile. Behind the study is a desire to improve the logistical situation by employing a single weapon in both roles. Possible helicopter application of *Shillelagh* would make this an even more attractive proposition.

Deceleration Tests Are Set at Eglin

Goodyear Aerospace Corp. is scheduled to launch the first of 12 missiles in the Air Force *ADDPEP* program at Eglin AFB on Nov. 7. Funded at $1.2 million, the project will undertake deceleration tests of parachutes and Goodyear ballutes at re-entry speeds as high as Mach 10. The 40-ft. missile is a combination of *Nike* first and second stages. Two of the 12 missiles will be fired at Holloman AFB, N.M. Involved are re-entry studies for nose cone packages, as well as tests for the *Gemini* program. Contracting agency is Aeronautical Systems Division.

Additional Flight Set for Gemini Program

Another *Gemini* flight has been scheduled. It will be an unmanned orbital flight scheduled to follow the project's first flight—now set for January, 1964. While some NASA officials refer to the new flight as simply a backup to the first, other well-informed sources predict it will go even if the first flight is successful, primarily due to the need for further study of the *Titan II* vibration problem.

NASA Investigates Car Sales At Cape

NASA is conducting a formal investigation into charges of impropriety in the sales of cars—previously rented by the space agency—to NASA and contractor personnel at the Launch Operations Center at Cape Canaveral. The investigation involves contractors, NASA personnel and Management Services, Inc. Fifty-nine cars were sold at low prices at a "public auction" in a restricted area to which the public did not have access, nine to NASA employees and 50 to contractor personnel.

Manned Space Flight Office Reorganized

Reorganization of the Office of Manned Space Flight will be announced this week, with the major change being appointment of George Low as Deputy Associate Administrator for Manned Space Flight. He will be in charge of development programs and also serve as acting head of the newly-established Project *Apollo* office. A Project *Gemini* office also will be set up. Current positions of deputy director for programs and deputy director for systems will be abolished.

Future Bright for NASA Supplemental

The Administration is expected to approve a NASA request for a Fiscal 1964 supplemental budget. It will cover the expected difference of about $150 million between the authorization of $5.35 billion and the expected appropriation of $5.2 billion. Pending approval of the supplemental by Congress next year, the budget reduction will not be allowed to affect the manned space flight program. The $150-million cut will be spread among scientific, weather and communications satellite programs and interplanetary spacecraft projects.

Time Marches On and On

There is considerable irony in suggestions that an up-rated *Atlas* might replace the vibration-plagued *Titan II* as a booster for *Gemini*. Almost three years ago, an ad hoc committee appointed by President-elect Kennedy recommended that *Titan* be considered as an alternative to the trouble-plagued *Atlas* in the *Mercury* program.

Decoy Measurement Presents a Problem

Technologists at the Atlantic Missile Range are finding it difficult to measure the dispersion of re-entry vehicle decoys from the path of a true warhead. Main problem is the brief time span between the ejection of the decoys and the end of the re-entry phase.

Administration Veto Expected on Chiefs Bill

The House Armed Services Committee's attempt to free the Joint Chiefs of Staff from fear of reprisal for speaking against the Administration by providing a single four-year term probably will be stifled even if enacted by Congress. Word at the Pentagon is that there will be stiff Administration opposition—forecasting a Presidential veto.

Out on a Toot

Comment overheard at the Pentagon about the background briefings on the abrupt resignation of Navy Secretary Fred Korth: "It's the first time a nuclear carrier has ever been used to lay a smokescreen."

INDUSTRY

Army Funds Pershing Decoys

Army is funding a decoy program for the Martin *Pershing* tactical missile at Aeronutronic Division of Philco Corp., a Ford subsidiary. Decoys are one of the major areas of interest at Aeronutronic.

Bendix To Get Minitrack Follow-On

Bendix Field Engineering Corp. will be given a follow-on contract for maintenance of the Minitrack Network. The incentive-type contract will be worth about $10 million and cover a two-year period from October, 1963, to September, 1965.

Collins System Chosen for Gemini Ship

Collins Radio has been selected to provide a radio command system for the Coastal Sentry Quebec tracking ship which will be used in the *Gemini* program. Contract calls for delivery of the equipment within seven months.

INTERNATIONAL

French May Increase Number of Missile Subs

Reports from Paris say the government is considering an increase in the number of French nuclear submarines to be operational in 1968-70 from three to five. Each will be armed with the *MSBS* missile, French-developed equivalent of the *Polaris*.

STL
NEW
PROPULSION
OPPORTUNITIES
In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

Requirements include a degree in engineering or science with appropriate experience.

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The Missile/Space Week

Williams Gets New NASA Job

Walter C. Williams has been named to direct operations for all NASA manned spaceflight missions.

Williams, now deputy director of the Manned Spacecraft Center, will supervise manned spaceflight operations at the Marshall Space Flight Center, MSC and the Launch Operations Center. During manned spaceflight missions, he will have full authority and responsibility for conduct of the flight.

His new title will be Deputy Associate Administrator for Manned Space Flight Operations. He will report directly to Associate Administrator for Manned Space Flight, NASA, Dr. George E. Mueller.

Williams has more than 23 years of flight engineering experience at the space agency. He directed all flights in the Project *Mercury* series.

Dr. Mueller said that an operations director was needed at NASA headquarters because "of the increasing complexity of the space agency's Manned Space Flight Projects."

James C. Elms, deputy director for Development and Programs of MSC, will assume full responsibility as Deputy Director under Robert R. Gilruth, director of the center.

NASA Boston Center Studied

A four-man committee has been appointed by NASA to study potential locations for its proposed Electronics Research Center.

The committee was set up after Congressional criticism of NASA's decision to build the center in the Boston area.

In authorizing the funding of the $3.9 million for the center, Congress stipulated that it could not be spent until after NASA Administrator James E. Webb transmits to Congress a report detailing the location, need for, and nature of the research center. House and Senate committees then will have 45 days in which to review the studies and indicate any objections.

Chairman of the survey committee is Francis B. Smith, chief of the Instrument Research Div. at Langley Research Center. Wendell H. Pigman, staff assistant at NASA Headquarters, has been designated committee secretary.

Other members are: Dr. G. Allan Smith, chief of the Guidance and Control Systems Branch, Ames Research Center; Dr. B. Richard Teare, Jr., Carnegie Institute of Technology; and C. R. Morrison, director of Program Support and Advanced Systems, NASA Office of Tracking and Data Acquisition.

Shots of the Week

Indonesia has entered the space age with an assist from the Soviet Union. The Indonesian Navy and Air Force have successfully fired guided missiles during the last month, according to Antara, the official Indonesian news agency. The missiles are assumed to have been of Russian origin.

Other shots of the week:

- The Army successfully launched its fourth overland *Pershing* shot from Ft. Wingate, N.M., into the White Sands Missile Range Oct. 21. A second scheduled shot the same day was cancelled because of technical difficulties.
- The USSR launched the twentieth shot in the *Cosmos* series on Oct. 18, some 20 minutes after NASA Administrator James E. Webb told members of a Senate Appropriations subcommittee that it was "about time" for the Russians to make such a move.
- The Air Force successfully launched a *Minuteman* ICBM Oct. 17 from Vandenberg AFB, Calif. Launch was routine training exercise conducted by a Strategic Air Command crew.
- A French *Veronique* rocket carried a cat into space Oct. 17 as part of a space biology research program. The animal was returned to Earth successfully by parachute.

Ginny Foils Launch Timetable

Hurricane Ginny's veer toward Cape Canaveral last week forced postponement of two launches and threatened to delay a third.

An Air Force Martin *Titan II* booster firing slated for Friday to test *Gemini's* malfunction detection system and attempt further Pogo vibration "fixes," was scrubbed. So was an *Atlas F* booster set for launching in the ABRES re-entry study program.

As the hurricane neared the Cape Navy officials remained hopeful that they could proceed with the scheduled Friday morning launch of a *Polaris A3* from the submarine Andrew Jackson. It was to be the first submarine launch of an *A3*. Other

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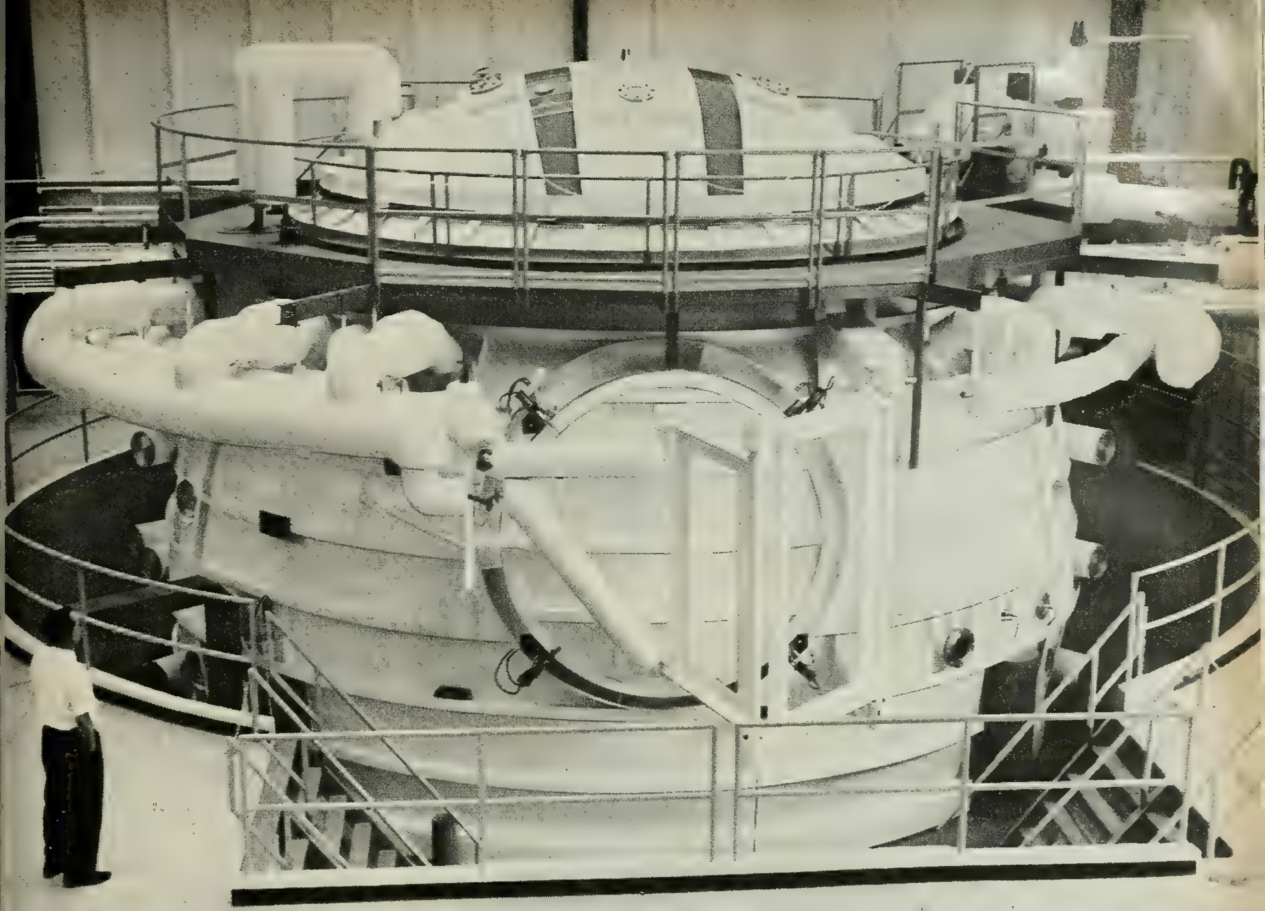
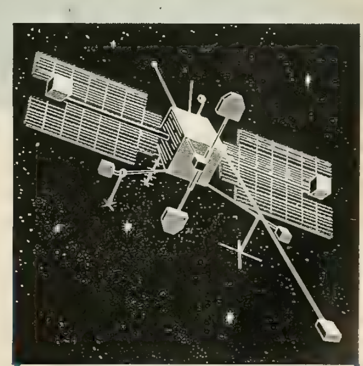




CB-632

OGO'S OUTER SPACE TEST TUBE A COMPLETE PROJECT BY CB&I

A new space simulation system which is now being used to test NASA's Orbiting Geophysical Observatory (OGO) spacecraft was completely designed and supplied by CB&I.

This is the largest system designed and supplied by a single contractor, without subcontracting the chamber, thermal system or vacuum system.

CB&I was awarded the complete project by TRW Space Technology Laboratories, designer and builder of OGO and other spacecraft in the nation's major space programs. The TRW installation is further demonstration of CB&I's outstanding reputation for designing, fabricating and constructing complete space simulation systems.

The next time you have an environmental testing system to be built —for space simulation or not—call on CB&I's complete capabilities. A "world of experience" awaits your inquiry. Chicago Bridge & Iron Company, Oak Brook, Illinois. Offices and subsidiaries throughout the world.

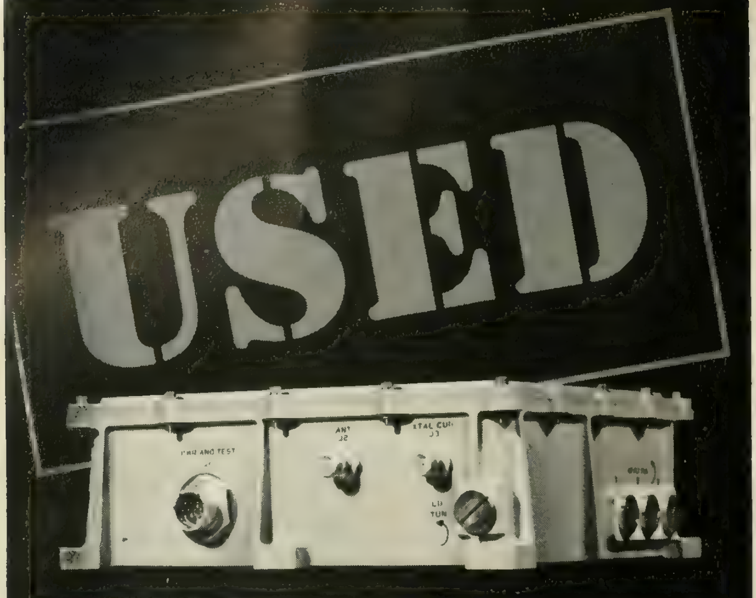
"Test tube" for OGO...

The high vacuum and temperature extremes needed to bring outer space down to earth are created inside a 30-foot diameter stainless steel Hortonsphere.® Here vacuums to $3x10^{-9}$ torr (equal to a 380-mile altitude) will be reached, with temperatures from −30 to +275°F.

Super-efficiency of the vacuum system was proved in test when $1 x 10^{-6}$ torr was reached in less than three hours of an allotted 12. A special feaure of the system is the diffusion pump trap — designed and supplied by CB&I — which permits egress of gas molecules while preventing entrance of oil molecules from the pump.

CB&I

designs them!
builds them!



TRANSPONDERS

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sources at the Cape were doubtful that the firing could take place on schedule.

NASA's *Atlas-Centaur* and SA-5 *Saturn I* boosters were left intact at their complexes. Both were believed to be stressed more than adequately to withstand Ginny's winds.

Space 'Watchdogs' on Duty

Three satellites launched at the same time Oct. 16 were reported last week to be in proper orbits—two of them checking against the possibility of clandestine nuclear explosions in space.

The two Air Force *Vela High Altitude* satellites were successfully "kicked" into circular, 57,000-mi.-high orbits Oct. 17 and 19, respectively. The two satellites are the first step in a U. S. plan to perfect a foolproof means to detect violations of the partial test-ban treaty.

Their instruments are designed to spot a sneak burst as far away as 200 million miles.

The 4.5-lb. "piggyback" tetrahedral research satellite that went aloft from Cape Canaveral aboard the same *Atlas-Agena* that boosted the "watchdogs" is in an elliptical orbit that will allow it to send back data on the Van Allen radiation belts. The smaller satellite was developed by TRW's Space Technology Laboratories.

Webb Airs Budget Woes

The *Rover* nuclear rocket and big solid propellant programs are likely to be among the first victims of impending NASA budget cuts.

NASA Administrator James E. Webb has told Senators holding hearings on the space agency's FY '64 budget that failure to restore the full amount cut by the House will force cancellation of "one or more" large programs.

Webb said it would be "short-sighted" of Congress to force such a decision since it would hobble the U.S. in areas in which it has a good chance "to jump the Russians."

The NASA chief's testimony indicated that firm decisions have not ye been made on these questions, bu must be soon.

Bad Diodes Delay Ranger VI

The launch of the lunar hardlanding *Ranger VI* spacecraft has slippe into the first quarter of 1964 becaus of deficiencies found in a shipment o small transistor diodes.

The launch had been schedule

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for the last quarter of 1963. The bad diodes were part of a shipment of these devices that had been installed in the spacecraft. NASA decided, however, to reschedule the launch even though the spacecraft had passed its acceptance testing at JPL.

The space agency said that the 242 diodes in the spacecraft will be replaced to assure that faulty diodes that could cause a malfunction in flight are eliminated.

The Ranger series—designed to take pictures of the lunar surface—has had five failures in five launches. The program is now over two years behind schedule.

Teller Scores U.S. Research

The U. S. is lagging behind the Soviet Union in applied research, according to Dr. Edward Teller.

The famed nuclear physicist, testifying last week before House Subcommittee on Science, Research and Development, said the U. S. rate of growth in scientific activity as a whole is falling behind that of many other nations.

Two areas that should be pursued with greater vigor, said Teller, are materials science and meteorology. Materials scientists should focus on new metals and ceramics, areas described by Teller as among the most important from the point of view of payoffs in about 10 years. He said the Soviets are particualrly good in this area.

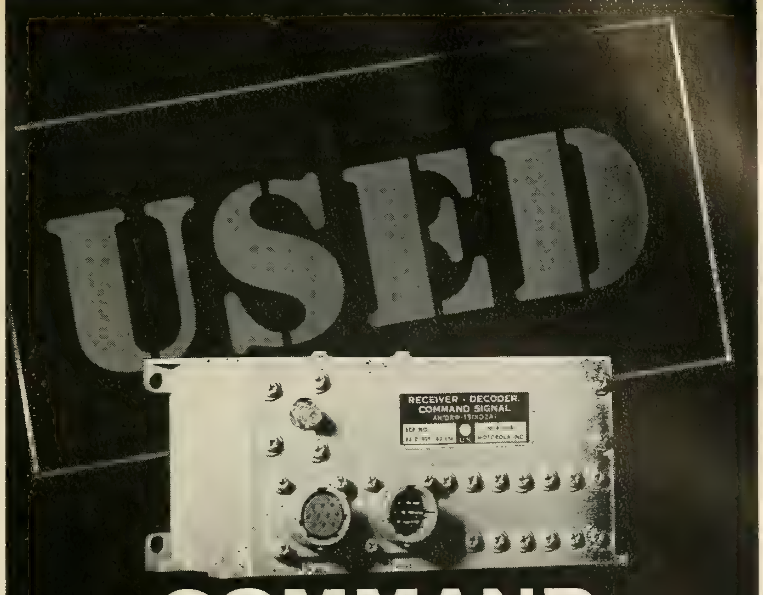
In meteorology, he would like to see the U. S. develop a weather-modification capability in addition to improved forecasting techniques.

5 Picked for LEM Guidance

Five contractors have been selected by NASA to develop the guidance and navigation system for the *Apollo* spacecraft's Lunar Excursion Module (LEM) at an estimated cost of $60 million.

The contractors—Massachusetts Institute of Technology, AC Spark Plug Div. of General Motors Corp., Raytheon Co., Kollsmann Instrument Corp., and Sperry Gyroscope Corp. —were selected earlier to build the guidance and navigation system for the command and service modules.

AC Spark Plug will provide the inertial measuring unit, including precision gyroscopes, navigation base, power and servo assembly and the coupling display unit. The firm will also assemble and test the complete system. Kollsman will furnish the scanning telescope, map and visual display unit. Raytheon will provide the onboard computer. A pulse



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integrating pendulum accelerometer will be furnished by Sperry. MIT is in charge of the overall management of the system.

Firms Bid for Sea Star

Program definition proposals for the Navy's *Sea Star* ship-launched rocket probe will be received from 12 firms. *Sea Star* is to be developed as a complete system with ground readout or recovery subsystems and launch equipment.

Hardware already in the Navy inventory is to be used where possible. Payloads for the probe are likely to include electronic countermeasures (ECM) packages, communications relays, and weather reconnaissance sensors. Navy's Bureau of Weapons invited 12 companies to define plans for a development program.

They include: Avco Corp.; Bendix Corp.; Ling-Temco-Vought, Inc.; General Electric Co.; Goodyear Aerospace Corp.; Hughes Aircraft Co.; Martin Co.; North American Aviation, Inc.; Raytheon Co.; TRW-Space Technology Laboratories, Inc.; Republic Aviation Corp.; and Radio Corp. of America.

AF Contracts Total $11.6 M

The Air Force Systems Command is developing an advanced integrated flight control system as a state-of-the-art program for use in future manned spacecraft.

AFSC said last week that the Air Force Flight Dynamics Laboratory has awarded $11,604,300 in contracts to three firms. The project is under the AFSC Research and Technology Div.

Of this, Litton Systems, Inc., Guidance and Control Systems Division, received $9.5 million for a control data system, system analysis and design integration. Lear Siegler, Inc.'s Instrument Div. received $1.9 million for advanced flight instruments, while Bell Aerosystems Co. received $100,000 to design a re-entry vehicle energy management system.

Young Named to Saturn Post

Robert B. Young will become Director of Industrial Organizations for NASA's Marshall Space Flight Center Nov. 1.

He will be succeeded as vice president and general manager of Aerojet-General Corporation's Sacramento, Calif., plants by Dr. Louis G. Dunn, recently retired chairman of the board of Space Technology Laboratories, Inc.

Dr. Dunn has been credited with directing the industrial team that developed the first U.S. ICBM and IRBM weapon systems during his tenure with STL. His term with Aerojet has been set at one year.

Young will manage for NASA the industrial complex developing and building the *Saturn I*, *Saturn IB*, and *Saturn V* launch vehicles to be used in Project *Apollo*.

PMR Testing for IQSY

Results of current Pacific Missile Range tests will qualify one of five sounding rockets for use in more than 200 solar experiments scheduled during the International Quiet Sun Year (IQSY).

First of the series to be fired from Pt. Arguello was *Black Brant III*, manufactured by Canadian Bristol Aerojet Ltd. Two more *Black Brants* are to be fired by July, 1964.

Three launches of the *DAC-Roc*, built by Douglas Aircraft Co., are planned for Arguello, as is one test shot of British Aircraft Corp.'s *Thunderbird*, previously fired twice from Pt. Mugu.

Also to be tested are the *Seagull* and Atlantic Research Corp.'s *Archer* sounding rocket.

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket

Rocket nozzles and convergent-divergent cones made of Great Lakes Carbon Corporation's **HLM-85** grade graphite are standard in the first stage solid propellant motor developed by Thiokol Chemical for the Minuteman missile.

GLC's **HLM-85** graphite is distinguished by high density, great erosion resistance and economy of performance.

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Photo by Thiokol Chemical Corporation

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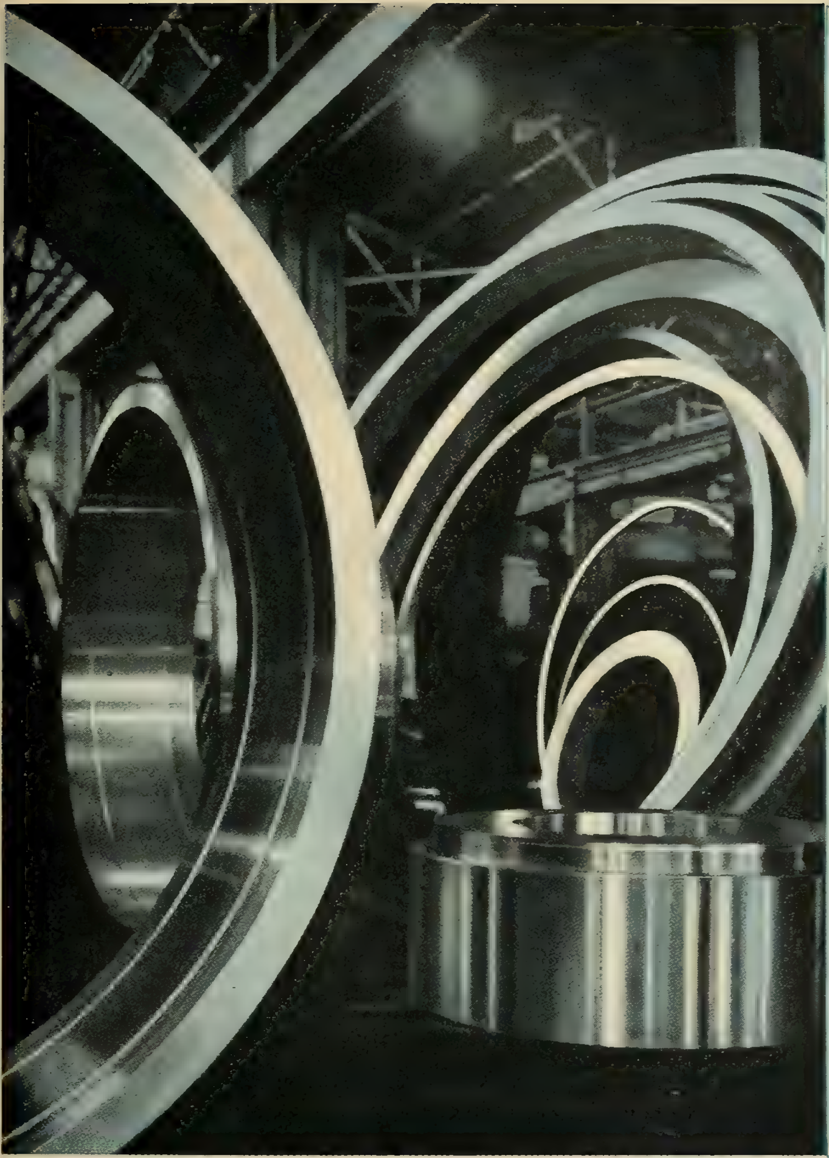

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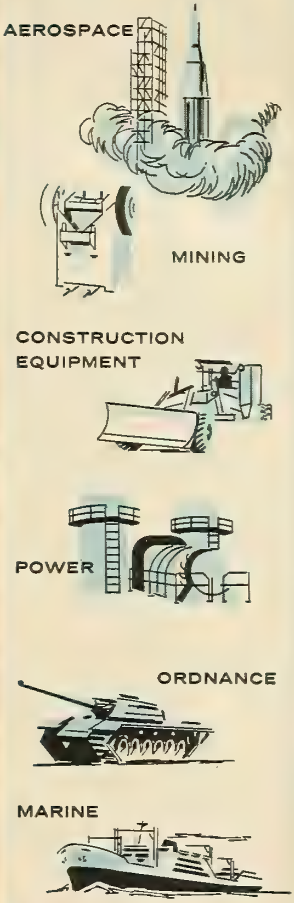

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At AUSA meeting . . .

Army Gives New Lance Details

Mockup given first public showing; spokesmen praise simplicity, versatility; Shillelagh also on display

by David C. Breasted

ARMY HAS RELEASED new details of its compact *Lance* surface-to-surface missile system, planned as a more flexible successor to *Honest John, Lacrosse,* and possibly *Little John.*

Mounted on its lightweight launcher aboard a tracked carrier, an engineering mock-up was one of the chief attractions in its first public viewing at last week's convention of the Association of the United States Army in Washington. Among the talking points of *Lance,* according to Army spokesmen, are 1) simplicity and economy, 2) choice of ranges spanning those of the earlier systems, and 3) mobility.

While the Army was frugal with details, *Lance's* range substantially exceeds the 20-mile advertised capability of the improved *Honest John* model.

Lance, equipped with a simplified inertial guidance system, is the first Army missile to use pre-packaged liquid propellants storable up to five years.

"We wanted something simple and cheap," said an Army spokesman. The Army is satisfied it is getting what it wants with a reliability bonus. But the decision to go ahead with production will depend upon *Lance's* performance after its current early stage of R&D.

The new missile is also the Army's first to go through program definition. As *"Missile B,"* it was well along in the thinking stage. About $75 million of a projected total of $100 million has gone into R&D.

Lance is designed for helicopter transport aboard its lightweight wheeled launcher. When mounted aboard its tracked launch vehicle, the whole unit can be carried and air-dropped from fixed-wing aircraft.

FIRST RELEASED photo of Army troops with Lance mockup aboard its vehicle

The complete, self-contained and self-sustaining unit consists of two FMC Corp. M-113-A-1 modified tracked vehicles. One of these is for launch; the other is fitted with a boom to lift the two reload missiles it carries onto the launch vehicle.

Lance also can be truck-towed on its small wheeled launcher. This is rolled or lifted aboard the launch vehicle, where its wheels and towing boom are neatly stowed on either side. Observers were favorably impressed with the minimum of fancy fittings. The 20-ft. missile is elevated and traversed with two artillery-style hand wheels.

Ling-Temco-Vought at Detroit is the prime contractor. Five major subcontractors are American Bosch Arma, Arma Division, (gyroscope); Systron-Donner Corp., Donner Division, (guidance components); North American Aviation, Rocketdyne Division, (propulsion); Telecomputing Corp., Whittaker Controls and Guidance Division, (gyroscope), and FMC Corp., Ordnance Division (vehicles).

- **Shillelagh shown**—Also on its first public view for 3,000 who attended the convention was Aeronutronic's Sheridan/*Shillelagh* system, mounted in an assault vehicle which can fire both surface-to-surface antitank *Shillelagh* and conventional 152mm ammunition from the same barrel. The vehicle, weighing 16 tons, is air-droppable. ■

Army Announces New Missile Deployment Plan

AN IMPROVED version of *Honest John,* and more *Sergeant* missile units are going overseas, the Army said last week.

The newer M-50 *Honest John* missile has a range of about 20 miles, up from about 15 for the M-31. The M-50 will be the primary weapon for missile battalions assigned to each of five divisions in Europe, two in Korea, and one in Hawaii. Each *Honest John* battalion has four launchers.

Two battalions of *Sergeants* are deployed in Europe. Earlier *Corporal* and *Lacrosse* systems will be gradually deactivated overseas.

DOD's Brown reports . . .

Accuracy, Payload, Cost Favor Ground-Based Anti-Satellite Systems

Program is now beyond study phase; Gemini/Dyna-Soar follow-on problematical

by Michael Getler

FARMINGTON, CONN.—The increasing accuracy of launch vehicles and the growing payload capability they can bring to bear favors use of ground- or sea-based interceptors rather than space-based systems for anti-satellite operations, according to Dr. Harold Brown, Director of Defense Research and Engineering.

The anti-satellite problem involves two phases—identification and intercept, Brown notes, and in both areas surface-initiated operations probably will come off best when measured against the Pentagon's favorite yardstick—cost-effectiveness.

"While identification may require rendezvous, which certainly is one thing that can be done well from space and is indeed an intrinsic part of an orbital space station program, I think that a considerable amount of identification can be done from the surface much more cheaply, though it won't buy the same kind of certainty," Brown declared during a speech at the recent dedication of United Aircraft Corp.'s new Corporate Systems Center here.

Brown also stated that "for a given booster, surface-launched vehicles will have greater accuracy and will have more payload than if you start from space and are aiming at another satellite. In view of this, the so-called hunter-killer capability from space is probably the wrong approach." Due to the attention focused on this area lately, Brown emphasized that he was "not trying to discredit the entire hunter-killer approach, but attempting to point out that the best way to go about it would be from the ground or the sea, not from space, insofar as achieving a particular end for a given investment . . ."

- **"Substantial work"**—DOD's spaceborne satellite interceptor program (*SAINT*) has been reoriented (M/R, Sept. 9, p. 16), and the Pentagon is now known to be pursuing development of ground-launched anti-satellite systems. Brown says these systems "are something that we consider important enough to be doing a substantial amount of work on." The program is known to have advanced beyond the study phase.

Brown also observed that in a contest between satellites and antisatellites, the hostile satellite can avoid the interceptor, at least for a few passes. Its advantage stems from the space environment and the lack of reaction with the atmosphere, a technique used to sort out warheads from re-entering decoys.

"The best clues as to what's a satellite and what's a decoy and the ability to track are considerably degraded. However," Brown adds, "if a satellite is going to be hostile, it probably has to be up for a long period, and long-time observation may give anti-satellites a chance in principle."

- **"Show-me" space attitude**—Brown also turned to the question of military man-in-space.

He said both NASA's *Gemini* and DOD's *Dyna-Soar* are limited in their ability to answer the question of what a man can do in space—a question that DOD has asked and has been asking for six years, with very few of the forthcoming answers regarded as possibilities. In general, these possible categories involve surveillance, repair of complex electronic equipment, and methods for recovering boosters.

Brown says that there is still "no well-thought-out plan, strongly oriented to near-Earth orbit, for a follow-on to *Gemini* and *Dyna-Soar,* though there is a study, and until questions regarding military man-in-space can find affirmative answers there shouldn't be any successor."

Study of this question is now being carried on in both agencies at a rate of about $1 million annually. Though no new money is requested for FY '64, Brown said that FY '65 could bring with it a lot of money for study and increased simulation, but still no development, even of components.

Brown emphasized that the follow-on funding, if there is any, will be dependent on what the current studies say is desirable. "If a follow-on were to be an enormous space station, capable of supporting a dozen people for a month or a year, clearly the amount of money we would have in '65 will not be enough to start development. Frankly, I cannot conceive of such a program being justifiable on the basis of what we know now. It may be justified later, but it certainly is not now. However, a modification of *Gemini,* some possible use of *Apollo,* or even a *Dyna-Soar* modification could be started on the basis of going programs without introducing a lot of additional money for manned space stations as such."

Brown reports that DOD's space efforts are and probably will remain more than 20% of total Defense R&D. Of this, almost two-thirds are directed at support missions "which we know we can do well"—such as communications, weather, navigation and mapping satellites—and general surveillance, an "ought to be done" area involving observation, tracking, identification and possibly interception. ■

Webb Says $11 Billion Needed in FY '64-65

NEW YORK—America's hopes of an *Apollo* manned lunar landing will slip out of this decade unless the program gets a total of $11 billion in obligatory funds for the Fiscal Years 1964 and 1965, NASA Administrator James E. Webb has declared.

Since the FY '65 budget will be sent to Congress late in January, Webb says, both the FY '64 spending figure, which is still to be finalized, the FY '65 plan, and any supplemental appropriations for '64 will have to be considered together.

He repeated an earlier warning that a stretchout of *Apollo* two to three years beyond its current target date because of threatened Congressional budget cutting will add another $2-3 billion to program costs (M/R, Oct. 14, p. 13).

To keep emphasis on the *Apollo* program, Webb indicated, the FY '65 budget proposal would be unlikely to include heavy funding for any space station or lunar logistics type of project.

Two civilians chosen . . .

New Astronauts Show Strong Academic Backgrounds

Group now totals 30, completing Apollo needs; three are primarily scientists, seven hold advanced degrees

by Warren Burkett

HOUSTON, TEX.—The academic training of the 14 new NASA astronauts seems intended to silence many who criticized the previous astronauts' lack of a scientific background. Three members are primarily scientists, and seven hold advanced degrees.

Youngest and best-educated of three space pilot groups, the members average 5.6 years of formal education in science and engineering beyond high school. Average age of the new astronauts is 31. They have averaged 2,300 flying hours, 1,800 in jets. From what little is known about Russia's cosmonauts, none of them approach these qualifications to perform the combined scientific, engineering and technical work expected of flying men in the expensive space program.

One man bridges the unmanned and manned space flight programs. He is R. Walter Cunningham, 31, a Rand Corporation scientist now completing his doctorate in physics at UCLA. A triaxial search coil magnetometer experiment, part of his work at UCLA, will fly aboard the first *Orbiting Geophysical Observatory*. He has 1,350 jet hours.

The other civilian, Russell L. Schweickart, 28, works as a research scientist at MIT's Experimental Astronomy Laboratory. Schweickart's masters thesis in astronautics (1963) dealt with stratospheric radiance. His present research is directed toward upper-atmospheric physics, star tracking and stabilization of stellar images. He acquired 1,100 jet hours during two active duty tours with the Air Force and the Massachusetts National Guard.

- **First PhD**—The Manned Spacecraft Center selection board found the first astronaut with a doctor of science degree in astronautics at the AF Space Systems Division. He is Maj. Edwin E. Aldrin, Jr., 33, whose 1963 dissertation dealt with problems of manned orbital rendezvous. Third man in the 1951 class at West Point, he has credit for 2,200 jet hours and two enemy planes shot down in Korea.

Other holders of advanced degrees, although primarily pilots, include:

Air Force Capt. William A. Anders, 30, a nuclear engineer and pilot for the Air Force Weapons Laboratory, Kirtland AFB, N.M. Annapolis graduate Anders received his masters of science degree from the Air Force Institute of Technology and did graduate work at Ohio State.

Air Force Capt. Donn F. Eisele, 33, also topped his Annapolis training with an AFIT masters.

Air Force Capt. Theodore C. Freeman, 33, also from Annapolis, took his masters in aeronautical engineering at the University of Michigan.

Air Force Capt. David R. Scott, 31, fifth in his 1954 class at West Point, earned a professional engineering degree and a masters degree in aeronautics during two years at MIT. His thesis was done on problems of interplanetary navigation.

Three of the seven who hold only bachelors degrees are completing work toward advanced degrees.

The seven are:

—Navy Lt. Cdr. Richard F. Gordon, Jr., 34, attending the Naval Post Graduate School, Monterey, Calif.

—Marine Capt. Clifton C. Williams, Jr., 31, of Quantico, Va.

—Navy Lt. Cdr. Roger B. Chaffee, 28.

—Navy Lt. Alan L. Bean, 31, NAS Jacksonville, Fla.

—Air Force Capt. Michael Collins, 32, Edwards AFB, Calif.

—Navy Lt. Eugene A. Cernan, 29, Monterey, Calif.

—Air Force Capt. Charles A. Bassett, II, 32, Edwards AFB.

The 14 new men complete America's Moon team. NASA plans to select no more astronauts until the fall of 1965. ■

Pauling, Fulbright Attack Apollo

DR. LINUS PAULING, 1963 Nobel Peace Prize Winner, called the U.S. manned lunar landing program a "pitiful demonstration" before an approving audience at the 100th anniversary celebration of the National Academy of Sciences.

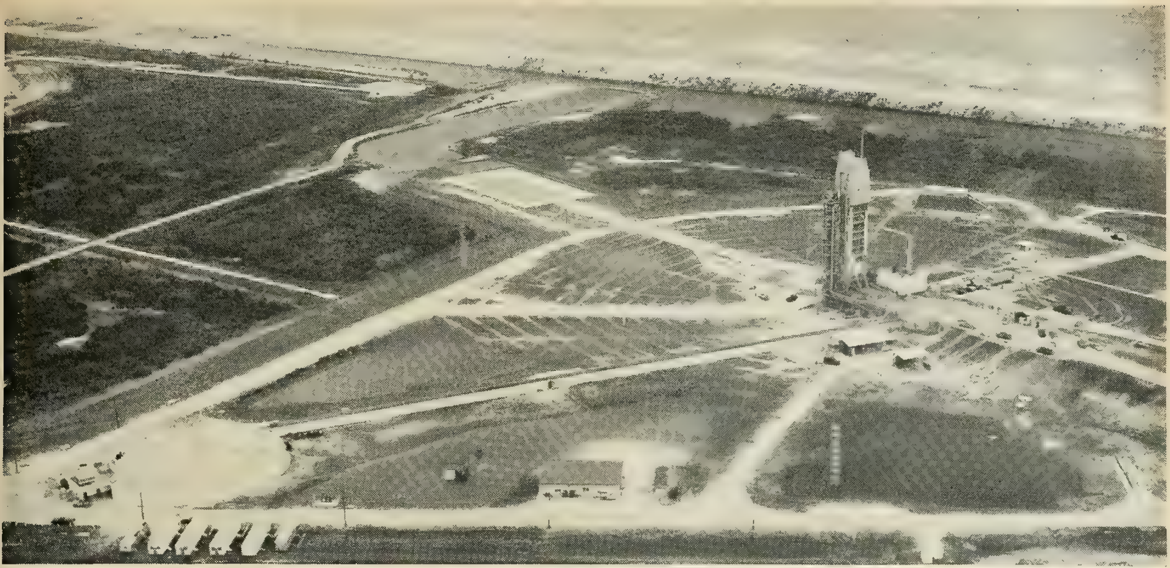
"Something is wrong with our values, when we plan to spend billions of dollars for national prestige," he declared.

Meanwhile, the Moon project was also attacked by Sen. J. William Fulbright, chairman of the Senate Foreign Relations Committee. Calling for a cut in NASA appropriations, he said in a Senate speech that "I have heard nothing to persuade me that it would be a national calamity if the landing on the Moon were delayed until 1980 or 1990."

Pauling, who also won the Nobel prize for Chemistry in 1954, began his attack on Project *Apollo* by noting that science already has the knowledge to discover ways to decrease significantly the amount of human suffering that exists in the world.

"We have the knowledge," he said, "the only thing we lack is money."

He suggested that human suffering could be significantly decreased if the same people and computers that are involved in getting Americans to the Moon were put to work unraveling the structure of life.



VIEW OF completed service tower and launch complex.

Before booster arrival . . .

Complex Ready for Gemini-Titan II

by Chris Butler

CAPE CANAVERAL—Modification of facilities and installation of man-rated equipment and instrumentation required to launch the *Gemini-Titan II* booster has been completed at Complex 19 here.

Nearly all target dates on a PERT-controlled schedule were met and Complex 19 was ready for the first *Titan II* built for *Gemini* before the Martin Co. completed preparations for flying the booster from the Baltimore plant to the Cape late last week.

John Gurr, Martin's complex manager, and Pete Abate, activations manager, said PERT played a major role in the work. It was the first time PERT was used for a launch facility activation, and its use extended to the point where individual systems engineers had their own PERT for pacing work.

Conversion of the complex to the manned space mission marked the 10th facility activation undertaken here by Martin since work started on Project *Vanguard*. Martin is the only R&D firm here which does its own activation work.

The extensive revamping program for Complex 19 got under way in the summer of 1962, with the Martin Co. and the U.S. Army Corps of Engineers sharing responsibilities for various areas of the work for the Air Force.

Martin handled conversion of facilities from *Titan I* to *Titan II* and the installation and checkout of all instrumentation. The Corps administered the contract for extending the service tower and installation of the "white room" for work on the spacecraft.

- **Propellant changes**—A survey revealed that few of the mechanical systems could be used without change or extensive modification due to differences in couplings, propellants and the physical size of the two *Titan* models.

Propellant transfer systems, formerly used for RP-1 and cryogenics, were removed and the carbon steel plumbing and connectors were replaced with stainless steel to handle the more corrosive propellants used on *Titan II*.

The propellant tank farm installed at Complex 19 has two 20,000-gallon tanks with heat exchangers to stabilize propellants at peak efficiency.

A system for venting fumes from propellants was installed, marking a distinct change from the disposal method used on other *Titan II* pads where such fumes are burned.

- **Brick and mortar**—All steel in the erector-service tower was sandblasted and painted before the Corps of Engineers moved in for the "brick and mortar" portion of the project.

The contract let by the Engineers provided for a section to be spliced into the erector-service tower, extending it to 138 feet in length, and adding a 140-ton, 50-ft.-tall, 25 by 25-ft. "white room."

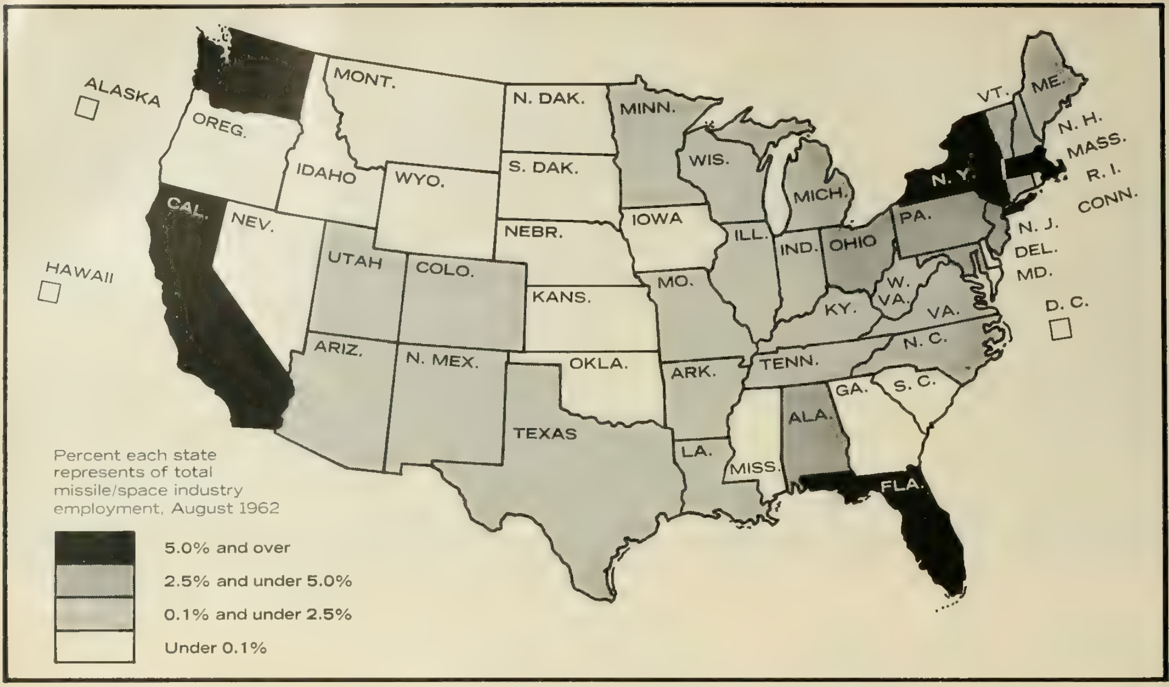
The room is air-conditioned to maintain a constant humidity of 50% and a 72° F temperature at all times. This necessitated expanding the air conditioning system for the complex.

A 102-ft. umbilical tower was redone to service the more complex booster and spacecraft. More than 800 miles of wiring in the blockhouse and test stand terminate in the umbilical tower, which also contains fuel, hydraulic, pneumatic and cryogenic lines.

The launch stand also was modified to provide separate side-by-side pedestals for static-firing both stages of *Gemini-Titan II*.

This necessitated building an erector system and a complete umbilical mast for the second stage to permit "sequence compatibility firing" of both stages to verify engine performance and the sequencer equipment to be used in flight.

The pre-conversion check revealed that between 90 and 95% of the instrumentation and all of the power supply systems were usable for the new launch vehicle. The power supply systems were refurbished down to the connector level, and parts were cleaned and replaced where necessary as part of the man-rating program. ■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Percent each state represents of total missile/space industry employment, August 1962
5.0% and over
2.5% and under 5.0%
0.1% and under 2.5%
Under 0.1%

MORE THAN HALF missile/space employment is in western states. (Source: State Employment Security Agencies.)

Profile of an Industry: Part I

Missile/Space Industry Rapidly Overtaking Automotive

Labor Department survey recognizes missile/space as separate industry, shows it heading for top spot in U.S. employment

by William Beller

(First of a three-part series.)

THE MISSILE/SPACE INDUSTRY, recognized by government statisticians for the first time as a distinct entity, now is vying with the automotive industry as top industrial employer in the United States.

Each industry will average out well over 700,000 employees on its payroll for 1963, a healthy margin over the close to 600,000 making steel and basic steel products—the nation's third largest industry in terms of employment.

On the basis of growth, there is little doubt that the automotive industry will shortly watch the missile/space industry pass it. Over a four-year period, employment surged 123% in the missile/space industry—from 319,300 employees in October, 1958, to 711,300 in August, 1962, according to U.S. Department of Labor figures.

In contrast, during the same period, employment in the automotive industry rose only 19%—from 606,500 employees in 1958 to 723,500 in 1962.

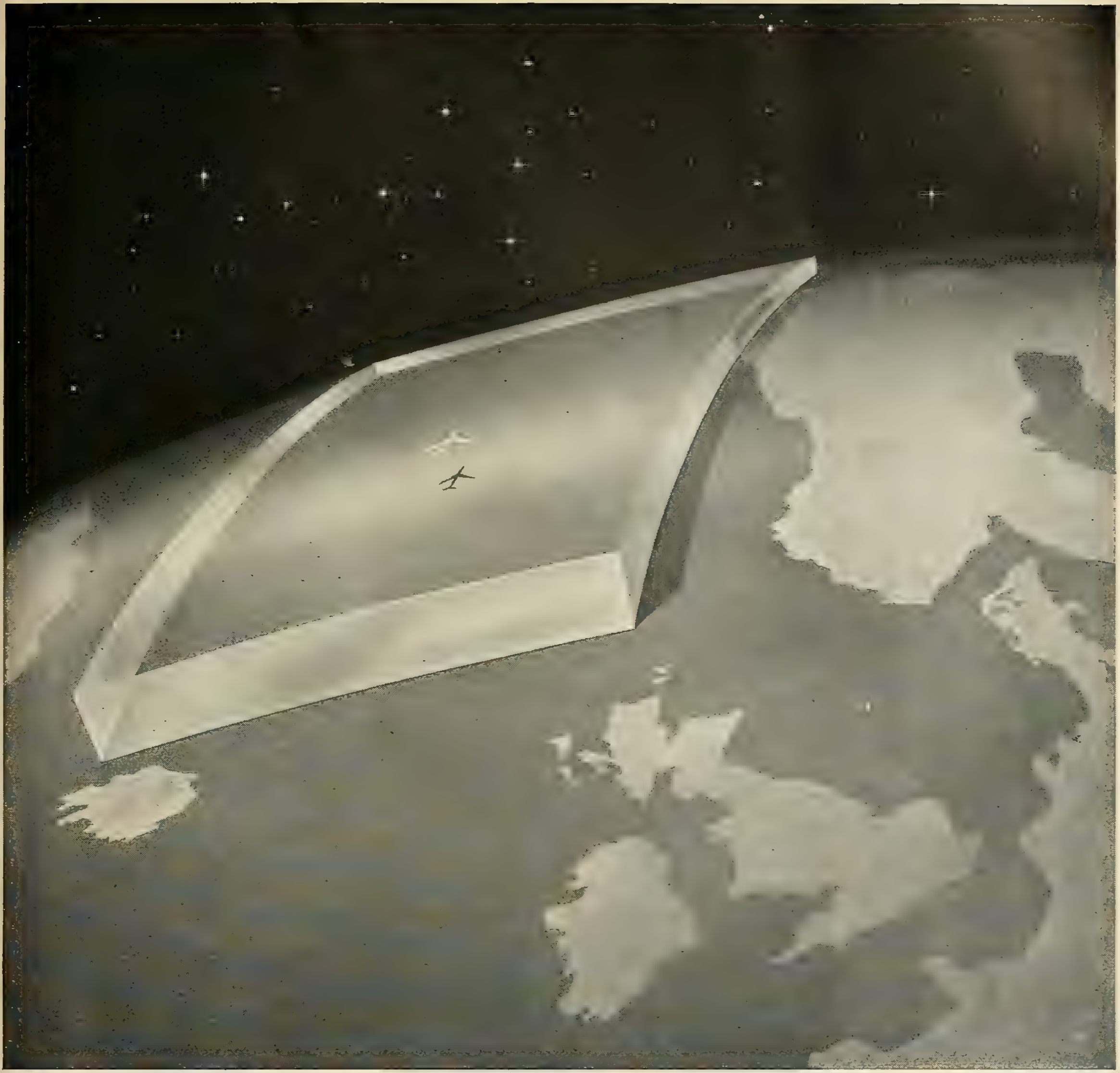
"I've never seen a field grow so fast in so short a time," F. A. Cisar, chairman of the interagency Technical Committee on Standard Industrial Classification, Bureau of the Budget, told MISSILES AND ROCKETS.

The missile/space industry, moreover, is still in a period of vigorous growth. This is indicated by a Labor Dept. survey showing a probable employment rise of 4.4% between August, 1962, and February, 1963, the agency's latest figures. The automotive industry, too, is showing a marked upsurge in 1963 employment as a result of more cars sold, but this is highly cyclic.

• **Missile/space, an industry**—Official recognition came to the missile/space field as an industry in its own right in the Labor Dept.'s Industrial Manpower Survey No. 105, issued earlier this year.

Missile and spacecraft activities, grouped together are defined as including "research, development, or production of complete missiles and space vehicles and/or component items—such as launching vehicles (rockets), satellites, missile airframes, ground-control and testing units, propulsion units, warheads, fuel, re-entry vehicles, electronic and other parts designed for inclusion in the missile or space vehicle—or in ground support equipment."

Not included are contract construction activities involving the building of missile launching bases or test sites.



RF space envelope...40 million cubic miles

This vast space environment—illuminated by hundreds of ground or airborne radars—can be created at will with a Reflectone simulator for SAC ground training.

Reflectone is producing Electronic Warfare simulators for the entire B-52 aircraft series. Each is equipped with a signal generator system which generates the complex illuminations in a 40-million-cubic-mile space envelope.

This RF space envelope is militarily applicable for years to come. It can be "placed" anywhere in the world to simulate virtually any environment which a mission might encounter under actual conditions. For example, in the morning the system might be used for continental U. S. training. The same afternoon, it could be programmed for a ready crew's strike assignment anywhere in the world.

Reflectone's signal generator system has been developed and proved in simulators for the B52B, F, G and H. For use in new aircraft configurations, this system would require development of only the student's mock-up station. Thus, through use of this advanced system, Reflectone can reduce development costs, insure reliability, and speed delivery—providing complex mission simulation well in advance of operational systems.

For further information on our capabilities, write Dept. MR-8.

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Circle No. 9 on Subscriber Service Card

STATE-OF-THE-ART REPORT ON SOLID PROPELLANT ROCKET MOTOR DEVELOPMENT AT UTC

Dramatic refinements in solid rocket motor technology during the past few years have greatly increased their usefulness. High-performance solid propellants, segmented motors, extended duration nozzles, thrust vector control, lightweight fiberglass casings, and simultaneous ignition of solid propellant clusters have all been successfully demonstrated — in the past 18 months — at United Technology Center. Current rocket motor programs at UTC apply the simplicity and reliability of these improved motors to such uses as giant boosters, upper-stage components, retro- and sounding rockets, and "hi-G" assignments for anti-missile weaponry.

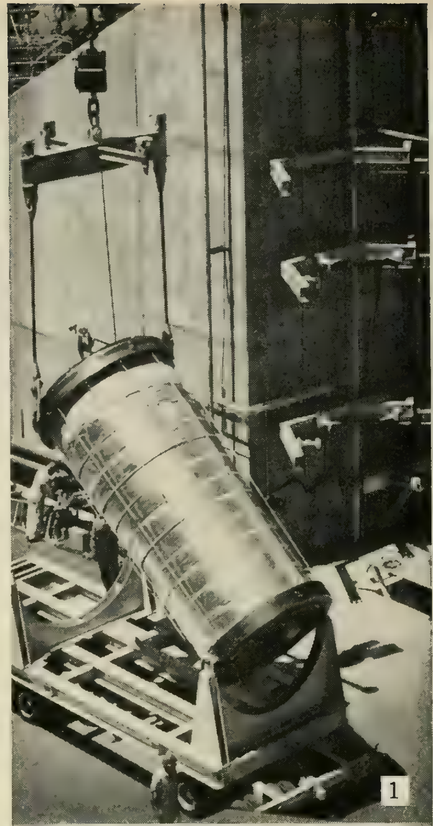
■ UTC pioneered the concept of large segmented solid propellant booster motors, and is prime contractor for the first stage of USAF Titan III C, the Standardized Space Launch Vehicle. Together, the two 120-inch segmented solid propellant motors which make up this booster stage will generate lift-off thrust of over 2 million pounds — more than 80% of the vehicle's total thrust. Identical motors, fired in larger clusters, could achieve the very large lift-off capability required for any space mission now planned for this decade.

■ Research and development programs at UTC — company funded and contractual — cover a broad spectrum of propulsion: solid and storable liquid propellant rockets, and hybrids.
The company's facilities, production capacity, organizational experience, and backup by United Aircraft Corporation equip United Technology Center to handle a variety of advanced propulsion assignments.

UNITED TECHNOLOGY CENTER

UTC

DIVISION OF UNITED AIRCRAFT CORPORATION



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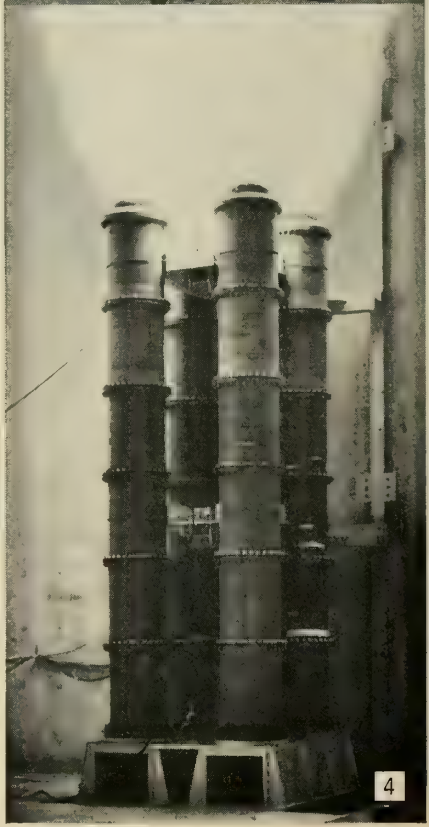

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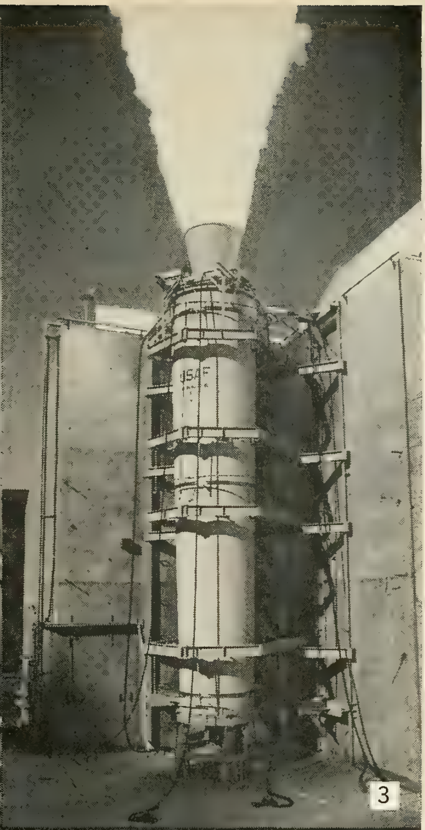
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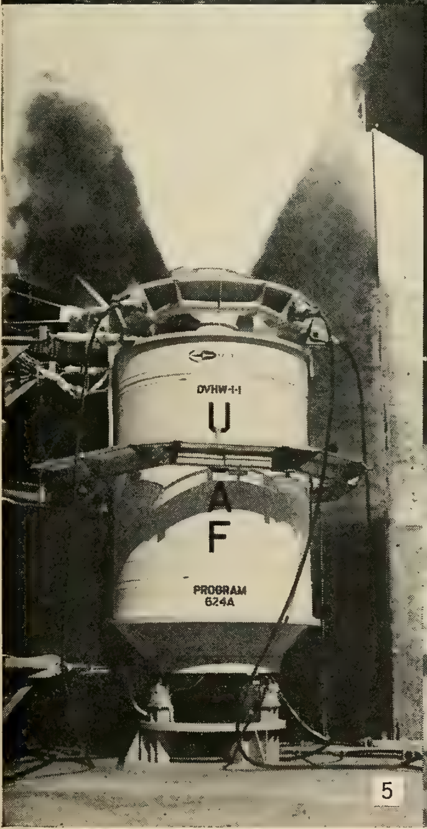
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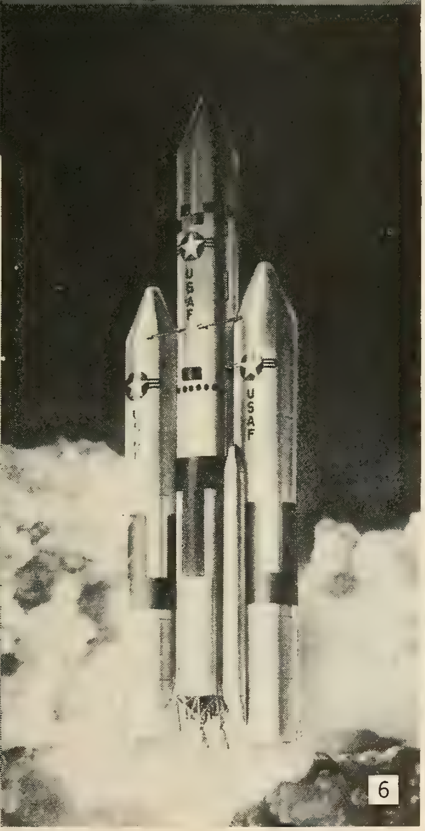
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1. Segmented solid rocket motor. The concept of large, segmented, solid propellant boosters, first advanced by UTC in 1958, has been brought to reality at the company's Coyote development center. Here, giant test bays have capacities up to 4,000,000 pounds of thrust.

2. Early feasibility test firings demonstrated the efficiency of UTC's unique clevis joint, key to the development of reliable segmented solid propellant rockets. Subsequent tests included the nation's first practical segmented fiberglass cased motors.

3. Company Funded R & D overcame intitial problems of large segmented solid propellant boosters: core design, exit nozzles, and thrust vector control. Test of USAF 35-ton motor verified UTC's preliminary results.

4. Clustered Solid Propellant Motors fired by UTC demonstrated simultaneity of ignition far exceeding manned launch specifications. Clusters of large solids can provide tens of millions of pounds thrust.

5. First 120-Inch Motor fired under USAF Program 624A produced peak thrust of 250,000 pounds during two-minute firing. Single-segmented test is first step in UTC's Titan III C development program.

6. USAF Titan III C. The first stage of this Standardized Space Launch Vehicle, consisting of two five-segment solid propellant rocket motors, 120 inches in diameter, will give this vehicle more than 2 million pounds of thrust at lift-off. It will orbit multi-ton payloads to low and medium altitudes.

Missile/Space Industry Employment by Size of Establishment, August 1962

Employment size (total plant employment)	Number of Establishments	Missile/Space Employment: Employees (thousands)	Missile/Space Employment: % Distribution	Total In-plant Employment: Employees (thousands)	Total In-plant Employment: % Missile/Space-	% Change in Missile/Space employment Aug. 1961 to Aug. 1962
TOTAL	**561**	**711.3**	**100.0**	**1,450.9**	**49.0**	**+16.7**
Under 250	84	6.7	0.9	11.0	60.9	−16.4
250-999	201	59.7	8.4	107.0	55.8	+ 9.4
1,000-4,999	202	232.2	32.6	462.0	50.2	+12.6
5,000 and over	74	412.7	58.1	870.3	47.4	+21.2

Source: State employment security agencies

Employment Trends and Labor Requirements in Reporting Establishments in Missile/Space, by Region and State, August 1962

Region and Selected States	Number of Reporting Establishments	Missile/space Employment August 1962: Total (thousands)	Missile/space Employment August 1962: % Distribution	Employment change (%): Past Trend Aug. '61 to Aug. '62	Employment change (%): Projected Needs Aug. '62 to Feb. '63
TOTAL	**561**	**711.3**	**100.0**	**+16.7**[1]	**+4.4**[2]
NORTHEAST	170	148.6	20.9	+12.6	+3.1
Massachusetts	29	47.0	6.6	+13.5	+4.2
New York	53	39.6	5.6	+ 5.8	+3.1
New Jersey	29	28.4	4.0	+12.2	+4.1
Pennsylvania	37	21.2	3.0	+36.2	+1.2
Connecticut	15	6.8	1.0	−11.4	−2.9
NORTH CENTRAL	98	77.5	10.9	+ 7.7	+6.1
Ohio	31	31.1	4.4	+12.2	+7.2
Minnesota	9	15.9	2.2	+25.4	+5.3
Missouri	9	10.4	1.5	− 6.8	+5.4
Michigan	12	5.9	0.8	−14.0	+6.2
SOUTH	94	126.8	17.8	+15.8	+5.1
Florida	19	36.9	5.2	+ 4.5	+2.2
Maryland	16	27.6	3.9	+10.1	+4.1
Alabama	14	24.7	3.5	+16.6	+6.6
Texas	14	13.6	1.9	+84.7	+7.3
Tennessee	3	6.9	1.0	+26.4	+1.1
North Carolina	6	6.2	0.9	−25.7	+2.1
WEST	199	358.4	50.4	+21.1	+4.3
California	167	265.0	37.3	+24.4	+6.6
Utah	7	16.7	2.4	+34.2	+2.7
New Mexico	7	8.3	1.2	− 3.1	+0.8
Arizona	7	5.2	0.7	− 4.9	+1.5

[1] Percent change is based on establishments reporting data for both 1961 and 1962; plants in matched sample account for 99 percent of total current employment.

[2] Based on estimated manpower needs of establishments with 99 percent of total current employment in surveyed plants.

Note: Listing includes States with at least 3 establishments and no plant accounting for 80 percent or more of employment total in reporting establishments to avoid disclosure of individual firm data. In addition, only States with missile employment of 5,000 or more are listed. Three States with large missile and spacecraft employment—Colorado, Washington, and Wisconsin—are not listed since this would disclose individual firm data. States are grouped by Census region.

Source: State employment security agencies

- **No home of its own**—Despite its recognition by the Labor Dept., the missile/space industry has only "foster homes" in the Bureau of the Budget's Standard Industrial Classification Manual, the basis of industrial figures.

Although 893 major basic industries are listed in the book, covering the whole of economic activities in the U.S., "rocket motors" and "guided missile engines and engine parts," for instance, are listed under "Aircraft Engines and Engine Parts"; "nose cones, guided missiles," under "Aircraft Parts and Auxiliary Equipment"; and "communication satellites" under "Radio and Television Transmitting, Signalling, and Detection Equipment and Apparatus."

The manual, nevertheless, is in the process of being modernized. For the first time, in 1963, "guided missiles and space vehicles, completely assembled" will be listed as a separate industry. But old habits are hard to break. It will appear under the major industrial classification "Ordnance and Accessories."

- **A trend reversed**—The ominous decline in the number of employees in aircraft establishments from the 1957 postwar peak was stopped and reversed in 1962, almost entirely by the missile/space industry. The aircraft industry was only one of many experiencing the impact of the new industry, including the electronics, chemical and basic materials industries which hired tens of thousands more people to meet the call for missile/space work.

The dramatic effect of the missile/space industry upon the aircraft industry is seen in the following figures: the aircraft industry suffered an employment loss of one worker in four from 1957 to 1961; in 1962, though, the industry's average monthly employment rose 5.6% to 707,200.

Leaving no doubt as to what caused this increase, the Labor Dept. survey states: "(this) overall gain in aircraft employment was due principally to increased missile and spacecraft activity within the aircraft industry."

The report also points out that "while employment in the production of aircraft increased one percent from August, 1961, to August, 1962, missile and spacecraft employment—which accounts for about one-third of all aircraft employment—rose about 23%.

In the overall picture, the number of missile/space workers exceeds substantially the total number of workers engaged in the development and production of manned aircraft. While missile/space industry employment within and outside the aircraft industry totaled 711,300 in August, 1962, the number of workers engaged in the development and production of manned aircraft was estimated to be only 535,300.

"The look ahead is for the missile

and spacecraft industry to grow even further away in size, worth and objectives," a Labor Dept. official told M/R, "until it is no longer recognized as once an offspring of the aircraft industry."

- **Character of the industry**—The missile/space industry, with its emphasis on research and development and its need for highly skilled personnel, has moved closer to what Stanford Research Institute terms an "architect-engineer" activity rather than a "construction" operation.

By the same token, the industry is also moving toward a more professional relationship with its sole customer, the government, analagous to that of the professional engineer with his client. Advice and management as well as hardware are valid missile/space commodities.

Each employee in the missile/space industry in 1962 accounted for $13,000 in sales, a relatively low figure, but not unexpected in the light of relatively small production runs and high wages. By way of comparison, the aircraft industry had $16,000 of sales per worker and the automotive industry, $21,500 per worker.

These figures are useful only for a character sketch of the missile/space industry and do not necessarily reflect either the return on total assets or the profit picture. In fact, a recent Stanford Research Institute study of the aviation and missile/space industries shows that the median return on net worth earned by 19 representative companies was 11.3% in the 1957-61 period, compared with the median of 9.8% for a "cross-section of U.S. manufacturing."

- **Type employees needed**—Most missile/space firms list manpower recruitment as one of the biggest problems. The greatest need is for engineers. Of the 561 plants considered in the 1962 labor survey, 265 of them—accounting for more than 70% of the missile/space employees in the survey—said they had immediate openings, particularly for electrical engineers.

Physicists, mathematicians and electronic technicians were among the shortage occupations in the professional (other than engineer) and semi-professional categories. Skilled workers, including tool and die makers, machinists and secretarial help, were reported in short supply, but the need for unskilled workers is negligible.

- **Dilemma of small firms**—Small plants in the missile/space industry have a difficult time growing up. If they are highly successful, they are eligible to bid on large systems contracts, but are undercapitalized unless they merge or are absorbed by large organizations. If they are moderately successful, they usually must move into hardware development and production to grow bigger —a difficult path. If they are just making ends meet, such as through study contracts, chances are they will not grow bigger and will soon disappear.

These are generalizations, verified by Labor Dept. figures showing that most missile/space employment is gravitating toward larger establishments. In August, 1962, 74 plants—about 13% of the total number surveyed—employed at least 5,000 workers each and accounted for nearly 60% of all missile/space employment. Moreover, nine of every 10 missile/space workers were employed in plants having at least 1,000 workers each.

Even though the large plants have large numbers of missile/space employees, they represent a smaller percentage of each plant's total work force than in plants employing fewer workers. In plants with 5,000 or more workers, missile/space employment constituted about 47% of the plants' work force, according to the 1962 survey, while in plants with less than 250 workers, missile/space employment represented about 60% of the plants' work force.

Underlining the employment trend, the largest establishment reported the largest employment gains. The increase from August, 1961, to August, 1962, in missile/space employment was 21% in establishments with 5,000 or more employees, while the gain was considerably less in medium-sized establishments.

On the other hand, among plants employing fewer than 250 workers, losses were reported that averaged more than 16% of the plants' total work force in August, 1961.

- **California leads**—California's pre-eminence in missile/space employment continued with the year ending August, 1962, when the state accounted for more than half the nation's total gain in missile/space workers.

Western states as a whole accounted for about 62,500 of the 101,800 workers added during the year. Other regions having significant gains: South (17,300) and the Northeast (16,600). In the South, gains were largely in Alabama, Florida, Maryland, Louisiana and Texas; in the Northeast, the chief gains were in Massachusetts, New Jersey, New York and Pennsylvania. ■

Employment Trends and Labor Requirements in Reporting Establishments in Missile/Space, by Industry Groups, August 1962

Standard Industrial Class. Code	Industry Group	Number of Reporting Establishments	Missile/space Employment August 1962		Employment change (%)	
			Total (thousands)	% Distribution	Past Trend	Projected Needs
					Aug. '61 to Aug. '62	Aug. '62 to Feb. '63
	TOTAL	**561**	**711.3**	**100.0**	**+16.7[1]**	**+4.4[2]**
372	Aircraft and parts	115	174.4	24.5	+22.8	+1.3
19	Ordnance and accessories	54	168.0	23.6	+12.6	+2.5
36	Electrical machinery, equipment and supplies	153	152.9	21.5	+22.4	+9.1
91	Federal Government	41	79.7	11.2	+ 7.4	+4.4
38	Professional, scientific and controlling instruments, photographic and optical goods, watches and clocks	37	34.3	4.8	+26.0	+6.2
73	Miscellaneous business services[3]	35	33.4	4.7	+17.7	+11.7
89	Miscellaneous engineering, nonprofit educational and scientific research services	17	24.9	3.5	+16.6	+6.4
35	Machinery, except electrical	39	17.1	2.4	+ 0.8	−4.1
28	Chemicals and allied products	13	9.8	1.4	+24.0	+2.1
—	Other industry groups	57	16.8	2.4	− 1.8	+3.0

[1] Percent change is based on establishments reporting data for 1961 and 1962; plants in matched sample account for 99 percent of total current employment.
[2] Based on estimated manpower needs of establishments with 99 percent of total current employment in surveyed establishments.
[3] Includes commercial research, development, and testing laboratories.
Source: State employment security agencies

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Who set out to make longer-wearing A and B oxide tapes—and did? AMPEX

For today's instrumentation applications, a demand exists for increasingly longer-wearing tapes. Ampex decided to meet the demand. Result? Two totally new instrumentation tapes formulated to meet A and B oxide MIL-SPEC and to provide longer wear characteristics. Not only do these new tapes offer far longer wear but also far superior performance. For example: Both new tapes are conductive and anti-static. They have less tendency to attract foreign particles. This makes for clean operation as well as longer life. Due to the uniformity of the new formulation, the occurence of dropouts is minimized. The new Ampex A and B oxide tapes provide higher resolution and improved general output characteristics. And each is application engineered. All this adds up to excellent performance, outstanding reliability. It has to add up to that. That's what Ampex set out to do. For more information write to Ampex Corporation, Redwood City, California. Sales and service offices throughout the world.

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Technical Countdown

PROPULSION

UTC Achieves Fast-Burning Propellant

A new propellant formulation capable of accelerating a rocket to more than Mach 8 in less than a second has been developed by researchers at United Technology Center, division of United Aircraft Corp. D. D. Ordahl, UTC's propulsion research manager, says the ingredients in the fast-burning propellant are basically the same as those in more conventional solids. The new propellant has a Class 2 or nonexplosives rating, and can be produced in quantity in present facilities with readily available raw materials. Such high-burning-rate propellants are essential to antimissile missile systems.

156-in. Subscale Jet-Tab Concept Tested

Lockheed Propulsion Co. engineers have successfully tested their SPEAR-5 solid motor with a subscale version of the jet-tab thrust-vector control system in spite of flooding rains and an earthquake. The motor used 7,000 lbs. of propellant. Lockheed will try the jet-tab system on a 156-in. motor early next year in the Air Force large solid-motor demonstration program.

ADVANCED MATERIALS

Martin Successful With Lightweight Zirconia

Specimens of a resin-impregnated zirconia foam have withstood re-entry simulation tests for 15 minutes without damage, says Eric L. Strauss of Martin Co., Baltimore Division. In a paper presented to the Eighth Symposium on Ballistic Missile and Space Technology, the Martin scientist described the material as a porous zirconia foam impregnated with a phenolic resin. The phenolic absorbs heat internally by pyrolysis, and the gaseous decomposition products cool the ceramic as they pass from the pyrolysis zone to the material's surface. The insulation efficiency of the zirconia foam was significantly higher than that of a graphite-phenolic ablator tested under identical conditions.

Impermeable Ceramic Developed

Researchers at the General Electric Lamp Glass Dept. in Cincinnati have perfected a 100% dense alpha alumina with a high resistance to alkali vapors at elevated temperatures. The ceramic remains stable at 1,900°C in an alkali-vapor environment during transverse rupture in bending of 45,000 psi. The material exhibits similar brittleness characteristics to other high-density aluminas but has a slightly higher thermal conductivity. It is easily machinable in a pre-fired condition, and has excellent dielectric properties in the final fired form. GE exports say the material will be applicable in nuclear power sources and other high-temperature electrical converters because of its extreme and unique density.

Mobile Fuel System Cleaner in Production

A mobile fuel system cleaner that uses vapors of Freon and trichloroethylene can ready a 28,000-gal. tank for cryogenic fuels in less than nine hours. The unit is in production at Avco's Spaceflight Programs Office in Tulsa, Okla. Company spokesmen say the Av-Mo-Vap system will revolutionize the on-site cleaning of hydraulic and pneumatic fuel loading systems at missile bases. The storage and loading systems must be cleaned before and after each launch. The Avco-built mobile complex includes clean rooms and controlled inspection areas.

ELECTRONICS

Something Done About the Weather

Through the use of a newly developed converter, facsimile transmissions of weather data can be processed directly into pictorial-forecast maps and area photographs. Revealed last week by United Aircraft Corporate Systems Center, the device, developed under the Air Force 433L program, accepts digital computer inputs and converts the data into analog form. Two units have been delivered to SAC Headquarters for the Global Weather Central.

Predicting Space Mission Success

A mathematical technique designed to predict instantaneously the success probability of a spaceflight any time during the mission has been developed by a Sylvania Electric Products, Inc., scientist. Based on the 100-year old Markov process and probability theory and now dubbed DRIFT (Dynamic Reliability Instantaneous Forecasting Technique), N. S. Jagodzinski says his approach analyzes data based on the immediate past to predict future events.

NASA Sees Need to Harness Space

For future space missions, NASA designers must learn to use the space environment, particularly for vehicle power, stabilization and control. So said Dr. Albert Kelley, director of Electronics and Control at NASA Headquarters, at last week's East Coast Conference on Aerospace and Navigational Electronics. In summarizing future requirements, Kelley indicated there was a need for increased use of direct digital processing and readout. Laser communication, he said, offers a high potential in space because of the lack of attenuation, high data rate and the possiblity of low power. He also pointed out that NASA expects to derive its space-qualified components as a product of its new electronics center expected to be constructed in Boston.

Navy Seeking 'Self-Healing' Circuitry

The Navy, in an attempt to improve airborne electronics, is looking toward "self-healing" circuitry. In line with its increased R&D efforts in computer technology, according to James Brearley, head of the BuWeps avionics branch, the Navy is just beginning to seriously investigate self-adaptive design techniques. The chief goal, he says, is for vastly improved reliability in modern weapons systems, but he also pointed out that there would be a resultant saving in future costs.

Week's Laser Advances Summarized

. . . Varian Associates has operated a new laser at 5,985 Angstroms using praesodymium ions dissolved in an optically clear crystal of lanthanium trifluoride.

. . . Raytheon has operated a new high-repetition-rate ruby laser at 10 pulses/sec. and with a measured average output of 2.3 watts at 6,943 Angstroms. Peak power was measured at 20 kw/pulse.

. . . General Electric has produced a series of five new electronic flashtubes for use as laser pumping sources. Biggest is a quartz tube, 1 x 36 in. long, that produces 100,000 watts/seconds (price: $440 each).

Natural Cork Providing Ablative Protection for Minuteman, Polar

NATURAL CORK—the bark of an ancient species of oak—is proving to be a highly efficient thermal ablation protection system in missile and space applications.

A processed sheet developed by Armstrong Cork Co. is already in service as exterior insulation on the second and third stages of the *Minuteman* ICBM, and also protects its interstages and guidance and control package.

The material is in use on the *Polaris* systems, *Thor-Delta, Scout, RAM B* and *Athena* vehicles.

And there is indication that cork may have a place in re-entry systems.

Armstrong's composition—Insulcork 2755—is a composite of cork and phenolic resins, and results in a material with char-forming ability and thermal insulating efficiency.

Since more than half the volume of cork is trapped air, Insulcork is only a third to a half as dense as other ablative compositions. The sheet material conforms to curved surfaces and can be adhesively bonded without difficulty.

Armstrong Defense Division spokesmen say the price advantage is "outstanding," when cost is equated with relative performance.

- **Nature engineers**—Cork is actually a natural resin foam with a cellular structure finer than any other naturally occurring or man-made foam. The individual cork cells are 14-sided and average about 0.001 in. across. There are more than 200 million such cells in one cubic inch of cork, and the thin but tough and impervious walls trap a considerable amount of air.

The natural cellular structure and lack of interstices are basic to virtually all of the physical properties of Insulcork 2755. The natural material complies completely with Lord Kelvin's thesis that it takes 14-sided bodies or areas to solve the problem of dividing space without interstices into uniform bodies of minimum surface dimensions. Natural cork is completely cellular.

In the Armstrong process, selected grades of prime cork are granulated uniformly after removal of waste and foreign matter. The cork particles are sized to pass a 16-mesh screen with retention on a 50-mesh screen. (U.S. Standards) This component of the Insulcork will comprise 78±3% of the total by weight.

The ground cork is then mixed with a thermosetting modified phenolic resin and polylol plasticizers. The mix is compressed into molds and baked dielectrically by an Armstrong-patented process. The procedure results in the retention of the unique cork cellular structure but augments other qualities. Sheets cut from the finished composition are uniform in density and other mechanical and thermal properties.

- **Successful re-entry tests**—Insulcork has been tested in the actual re-entry environment. Researchers at NASA's Langley Research Center fitted the material to a four-stage *Scout* vehicle. The fourth stage fired the payload back into the atmosphere.

The aluminum re-entry structure was covered with an epoxy compound except for the tip, on which a nylon-phenolic material was used. A one-piece strip of 0.25-in.-thick Insulcork 2755 was wrapped around the payload with the ends bevelled at the joint (See photograph).

During re-entry, the flight data showed a peak velocity of 11,000 fps at a corresponding altitude of about 65,000 ft. Subsonic speeds were reached about 40 seconds after achieving maximum velocity. Recovery was by parachute with a water impact at 60 fps.

Surface temperatures at maximum velocity were calculated to be slightly more than 2,000°F, with a 60 Btu/sq. ft. heating rate. Backface temperatures were essentially ambient.

The cork adhered firmly to the substrate during the test, with ablation essentially following the original contour. The strip was virtually intact on recovery. A small portion had broken away either at impact or because of subsequent handling.

Approximately 33% of the original surface thickness had ablated.

- **Ascent heating**—Cork is used extensively on the *Minuteman* to provide thermal protection during silo launch and atmospheric ascent. During the initial silo launch phase, 3,000°F exhaust gases are expelled past the rising vehicle. Ascent flight thermal environments are caused by aerodynamically induced convective heating on the vehicle exterior and recirculating hot exhaust gases in the base area.

The main considerations in material choice for external insulation for the weapon were thermal efficiency and ablation characteristics. Cork was found to be thermally superior to other external insulation materials. Since significant range gains could be anticipated because of partial ablation of insulation materials on each missile stage during launch, the material chosen would have to have real ablating weight advantages. Again cork met the test.

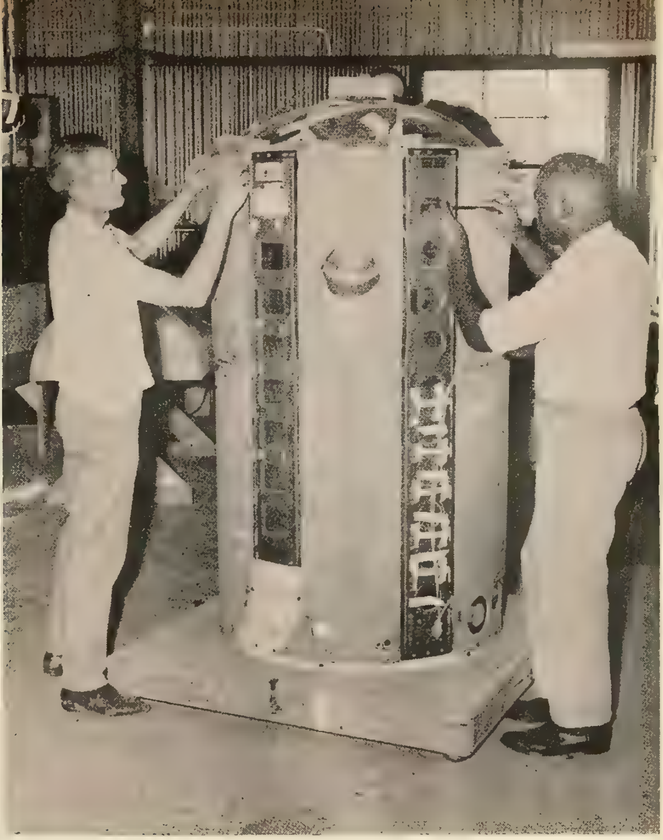
While *Minuteman* researchers were determining the physical properties of sheet cork, a concurrent program evaluated applicable processing and installation techniques. This program covered optimum bonding, sheet joining, and shop and field repair techniques. It also involved materials and techniques to insulate flush and protruding bolt heads in the presence of surrounding cork insulation, and the determination of methods to maintain the density of cork to within 5% of nominal value.

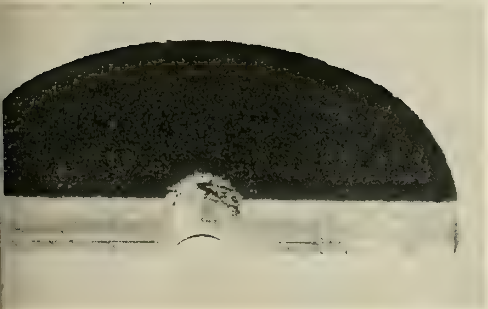
The program demonstrated the effectiveness of Armstrong and other adhesives when applied to properly cleaned and primed surfaces. Scarf joints of 30, 45 and 60 degrees, and the notch-type joint were all acceptable.

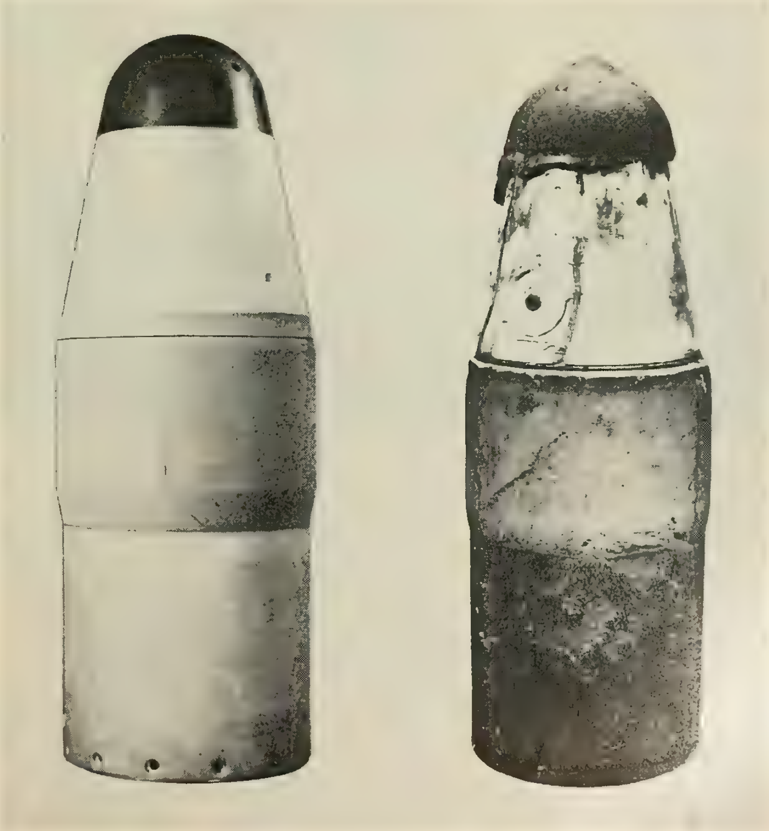
A butt joint loses tensile strength at 200°F. These are not recommended where joints are critical in tension.

Both mechanical and chemical methby John F. Judge

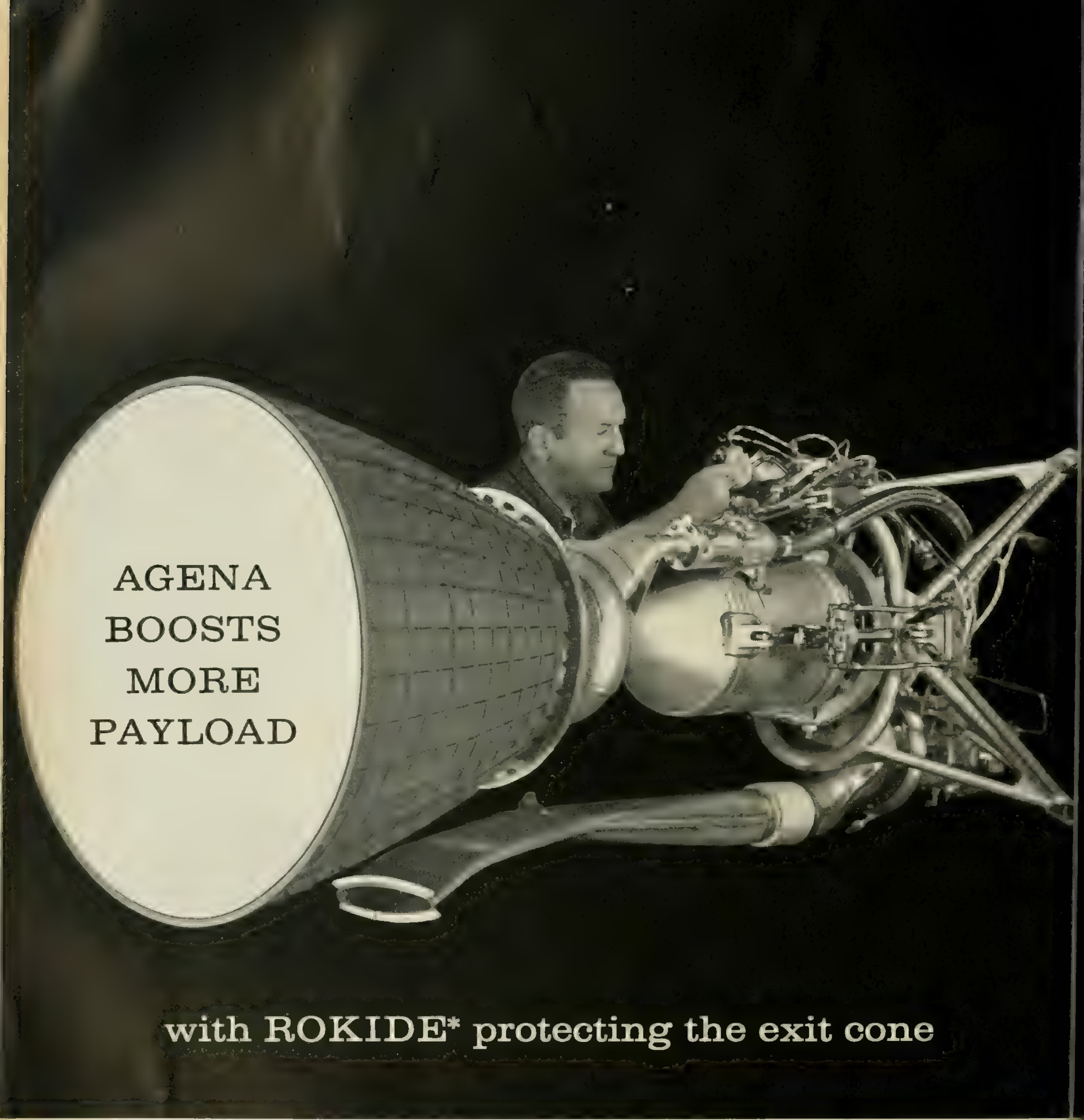
out







ABOVE RIGHT: Cork insulation has been applied to exterior of this experimental engine and technicians are completing final details before application of a protective coating. ABOVE: Plug taken from re-entry vehicle cork band shows relatively thin and smooth char on remaining surface. About 33% of the 0.25-in.-thick cork composition ablated away. RIGHT: Comparison of experimental re-entry vehicle before and after re-entry shows uniform ablation effect on cork band around structure's center. General shape of cork band was maintained, except for upper portion, which was removed with epoxy substrate.



The Agena liquid rocket engine, built by Textron's Bell Aerosystems Company, has been assigned to numerous space projects to date, including Ranger, Mariner, Gemini — and has orbited more functional payload weight in space than any other engine.

For added thrust, Agena now has a TIMET titanium nozzle extension . . . uncooled and lightweight, spray-coated with Norton ROKIDE "A" (entire white area inside exit cone). ROKIDE contributes to Agena reliability by providing a stable thermal barrier during full engine operation, including thermal shock resistance during rocket ignition and inflight restart.

With superior thermal, mechanical, electrical properties, ROKIDE "A" aluminum oxide and ROKIDE "Z" zirconium oxide offer built-in protection for any satellite or missile surface exposed to severe temperature gradients and abrasive atmospheric friction.

Coating facilities are maintained at Norton plants in Worcester, Massachusetts and Santa Clara, California. Licensed applicators in key cities. Write NORTON COMPANY, Refractories Division, 689 New Bond St., Worcester 6, Massachusetts. In Canada, NORTON COMPANY OF CANADA LTD., Hamilton, Ontario.

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ods of cork removal were evaluated. Methylene chloride can be used to strip cork from an isolated part, but is unsatisfactory for removing a section from an installed sheet. Routing tools can be used in making cork repairs.

Mismatches of 0.10 in. were found to be acceptable, with sheet cork ramps handling small, local protuberances.

- **Moisture and coatings**—Cork density increased up to 128% by weight during temperature/humidity cycling tests. But constant temperature/humidity tests (160°F-95% R.H.) indicated to investigators that the increase in cork density will never exceed 8 to 11% under actual usage conditions.

The program also showed that sheet cork coatings were not necessary for retarding moisture absorption, but would perform a useful function in blocking accidentally applied materials such as oils or fluids. Fungus preventive coatings are effective in blocking attack from these agents.

Sheet cork is currently considered to be generally qualified for use as aerospace vehicle thermal insulation within the following boundaries established in the *Minuteman* qualification programs.

Heat Flux	
Types	Conductive/radiant
Heat Rate (hot or cold wall)	0 to 300 Btu/ft^2/sec.
Enthalpy Range	0 to 3000 Btu/lb.
Aerodynamic Shear Stress	0 to 8 lb./sq. ft.
Low Velocity Gas Temperature	0 to 3500°F
Pressure Altitude	Sea level to 300,000 ft.

Configurations for application—structure exterior, stagnation areas such as raceway caps, and base areas.

INSULCORK 2755

ABLATION DATA—ARC-JET PLASMA

HYPERTHERMAL CONDITIONS		
Convective Heat Flux, Btu/ft.^{2}/sec.	100	500
Exposure Time, sec.	46	24
Enthalpy of Gas at Nozzle, Btu/lb.	1,000	3,329
Stagnation Pressure, psig	0.307	0.704
Temperature of Gas at Nozzle, F.	3,162	6,748
SAMPLE PERFORMANCE		
Original Density, gm./cc.	0.528	0.542
Density after Test, gm./cc.	0.453	0.471
Weight Loss, gm.	9.887	8.561
Maximum Erosion Depth, in.	—*	0.389
Erosion Volume, in.^{3}	1.001	0.808
Apparent Av. Erosion Rate, in./sec. x 10^4	—*	166
Apparent Av. weight Loss, gm./sec. x 10^3	—*	357
Total Weight Loss, %	57.0	48.4
FINAL SAMPLE TEMPERATURES, F.		
Back Face	112	116
Front Face, Optical Pyrometer	2,723	4,019
Front Face, Total Radiation Pyrometer	2,372	3,830
Apparent Emittance	0.49	0.73
Apparent Time Surface Temperature	2,893	4,441.5

* Run stopped because of visible penetration of sample.

- **Application easy**—Insulcork can be applied to flat or curved surfaces. It will contour to most surfaces that do not have sharp protuberances or voids through vacuum bagging techniques. Armstrong has a trowelable mastic—Insulcork K5NA—to handle surface irregularities.

Application techniques do not normally involve unusual surface preparations, bonding techniques or special materials. There are a variety of adhesives available, but epoxy type formulations have been found best for aerospace applications.

The cork material can be easily sawed, routed, bevelled, drilled and sanded using conventional woodworking tools and techniques. Dimensional accuracy with respect to fitting is best maintained if the material is kept in a uniform temperature and humidity environment.

Substrate preparation consists of either solvent wiping, mild abrasive cleaning, sand blasting or chemical etching, depending on the nature of the surface. Voids and sharp protusions can be filled with the cork mastic.

The ablative cork composition is usually bonded to metal or plastic surfaces with epoxy adhesives. Vacuum bag techniques are applicable, and the cork can be compressed in final assembly to assure tight seams and good adhesive contact of cut surfaces.

The bonding can be processed at room temperatures or higher thermal conditions if better and quicker results are desired.

Armstrong has long been active in the defense area. Recent contributions include Luneberg Lens media for the *Nike-Zeus*, artificial dielectrics, ablation materials, polymeric binder studies for solid rockets, cryogenic materials, vibration damping, acoustical treatment, adhesives, coatings and special foamed plastics. ■

The Cork Business and How It Started

CORK IS NATURE'S AGENT for protecting the cork oak tree from the hot, dry desert winds known as siroccos. The trees grow in a narrow belt stretching for more than 1,500 mi. along the coasts of Portugal, Spain and France and a 1,000-mi. strip along the coast of North Africa.

This area, about the size of New Jersey, is the world's major supply of cork, although there is evidence the trees once surrounded the entire rim of the Mediterranan basin. The civilizations of Phoenicia, Asia Minor and the Balkan Peninsula left only traces of cork oak stands in the eastern Mediterranean.

The evergreen cork oak ranges from 30 to 40 ft. in height at maturity with trunks a yard or more in diameter. The average life is 150 years.

Cork as we know it is the outer bark of this tree—periodically stripped from the trunk to heights set by law in the various cork-producing countries. First stripping must wait until the tree is between 20 and 30 years old; subsequent stripping operations take place every nine or ten years thereafter.

The bark grows in two layers. An inner layer called phellogen is live and acts as a base for the outer layer, which is dead and serves to insulate the tree from the hot winds. The bark is cut, processed, graded, baled and shipped to processors all over the world.

The American cork industry started around 1830, when Stephen King, a Scottish immigrant, opened his cork-cutting shop on Water Street in New York City. The U.S. decennial index of 1850 first mentions a cork industry with a total of 14 cork manufacturing firms. The products were cork stoppers and other items cut from cork wood. Some 10 years later, in 1860, the city of Pittsburgh saw the founding of a small cork-cutting business by Thomas M. Armstrong in partnership with John D. Glass. From this one-room bottle-cork plant the firm expanded over the years through cork and allied products and then into the general fields once supplied by cork manufacturers with other product diversification.

As of 1963, Armstrong Cork has assets exceeding $220 million with annual sales of more than $300 million. Although cork now is but a small part of the total picture, its curious structure and innate insulative characteristics are carrying it into the highly complex space and missile field.

The firm produces the ablative cork composition at both its Lancaster, Pa., and South Gate, Calif., facilities. The Armstrong Cork Co. Defense Division handles all aerospace research, development and products.

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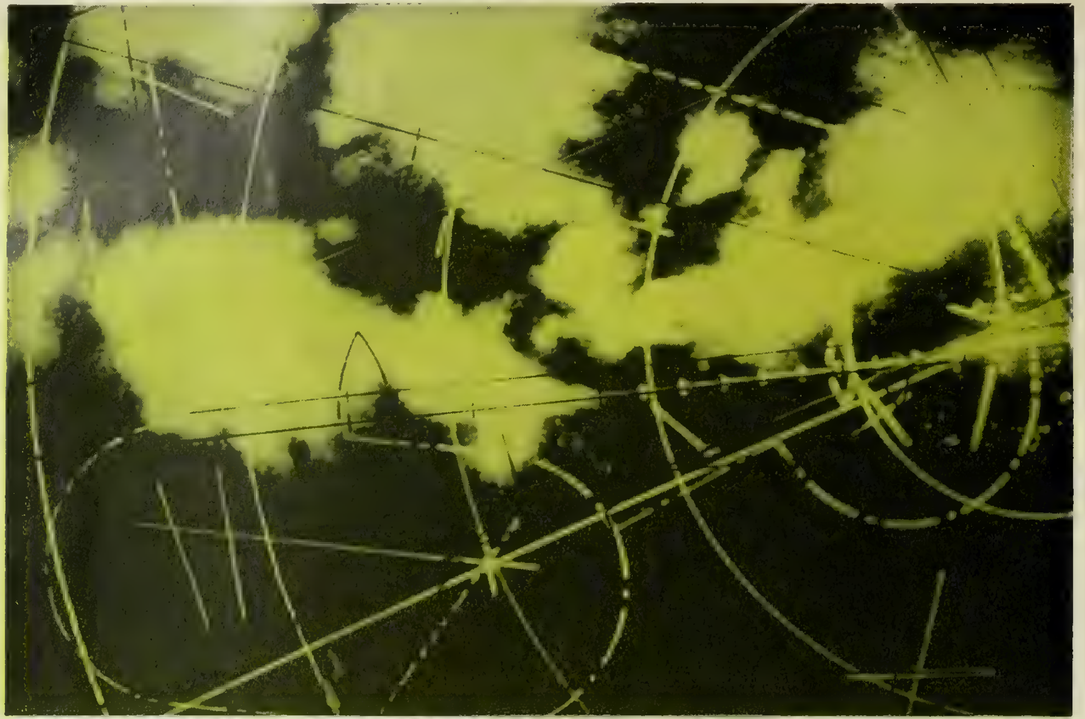
"Microwave tube research at Varian isn't always directed toward major technical breakthroughs. Many company-funded programs are aimed at less glamorous goals, such as increased tube reliability. To develop more reliable tubes, our R&D people must identify, understand and eliminate the causes of tube failure. Right now, we're doing promising work on field emission points, in hopes of eliminating high-voltage breakdown in high-power tubes. ❋ Work of this kind sometimes has very beneficial side effects. A research program on reliable cathodes led to a major breakthrough in vacuum technology, the invention of the VacIon® pump. We use these pumps extensively in our manufacturing operations, and they have substantially increased the reliability of our tubes. This was, after all, the basic objective of the research program." *Dr. Theodore Moreno (left), Manager, Palo Alto Tube Division. Dr. Moreno is shown here conferring with Varian research scientists, Dr. Ivor Brodie (standing) and Dr. Daniel Dow (right).*

MICROWAVE TUBE GROUP VARIAN associates



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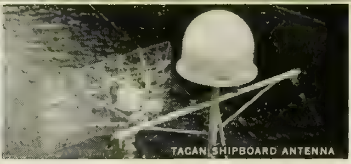

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ITT

Solid-State System To Track X-20

Device to provide craft high antenna gain to aid data transfer and communications

DYNA-SOAR tracking antenna (center) employs conical scanning by means of a rotating offset waveguide feed near reflector focus point. Twenty-ft. diameter antenna in background is a phased monopulse system with a 200 to 2,300-mc bandwidth.

COMPLETELY SOLID-STATE ground antenna tracking systems for the Air Force's *X-20* manned orbital glider have been developed by Radiation, Inc., under contract to Radio Corp. of America. Developmental models of the systems have now been delivered and accepted by RCA, according to RI officials.

Set for use in the upcoming *Dyna-Soar* flight test program, the systems will acquire, track and provide two-way broadband communication and data links with the space vehicle. The tracking systems are designed for use in both land-based and shipboard applications, with line-of-sight stabilization provided in shipboard versions.

Prime objective of RI's *X-20* hardware effort is to provide high antenna gain and direct this gain toward the *Dyna-Soar* vehicle in flight to permit air-to-ground and ground-to-air communications and data transfer. A secondary objective is to provide precision readout of target angular coordinates relative to the ground station to assist in determining vehicle position.

The high antenna gain will permit simultaneous reception and transmission with a single antenna of technical data at high microwave frequencies on telemetry links. (Specific operating frequencies of the program are classified.)

The automatic tracking antenna systems include a 12-ft.-dia. azimuth-elevation antenna having a 0.4-degree beamwidth, electric drives and fully transistorized control circuitry. The antenna transmits right circularly polarized energy and receives right or left circularly polarized or linearly polarized signals.

In addition to polarization diversity reception, other advanced system features include:

—tracking accuracy better than 0.1 degree under anticipated practical conditions of combined target motion and ship's motion;

—exclusive use of solid-state circuitry in the servo control system;

—availability of nine target acquisition and tracking modes, including fully automatic tracking initiated when RF signal strength exceeds the pre-set carrier relay threshold;

—application of digital NOR logic to facilitate the automatic selection of the highest priority operational modes.

The general configuration of the system consists of a 12-ft.-dia. paraboloidal reflector mounted on an elevation-over-azimuth axis pedestal. Conical scanning of the antenna beam is produced by use of a rotating offset waveguide feed supported near the focus of the reflector. Tracking error signals are derived from the conical scan modulation imparted to the received RF signals from the *Dyna-Soar* vehicle.

The tracking electronics subsystem, which is housed in three equipment racks each measuring 24 x 24 x 72 in., functions to process the tracking error signals and to generate appropriate steering commands to keep the antenna pointed accurately toward the target.

• **Target acquisition**—The need for high antenna gain, said Radiation, Inc., officials, required a narrow antenna beamwidth. The narrow 0.4-degree beamwidth, coupled with probable angular uncertainty of the target position, in turn created severe requirements concerning initial acquisition. Target re-acquisition required equal attention, because of the possibility of signal disruption. Consequently, great emphasis was placed on system analysis and equipment design with respect to problems of acquisition and re-acquisition.

Analyses indicated that reaction times required during the acquisition and re-acquisition procedures would be substantially beyond the capabilities of a human operator. As a result, considerable recourse was taken to automatic acquisition and re-acquisition features.

Pre-established action sequences are initiated automatically upon signal detection or upon loss of signal, with the operator having the capability of modifying the programmed sequences or of otherwise intervening at any time.

Throughout system design, one engineer pointed out, is reflected the philosophy of exploiting the operator's capabilities for accepting external inputs in a variety of forms and exercising judgment, and exploiting the machine's superior capabilities for reacting quickly and precisely to prescribed inputs.

• **Operational modes**—Nine modes of operation are provided in the system in recognition of the probable wide range of operating conditions. A majority of these modes have to do with target acquisition and re-acquisition.

The various operational modes reflect detailed analyses of the *Dyna-Soar* mission, the character and incidence of anticipated plasma attenuation, the quality and availability of external sources of tracking information and the vehicle trajectories at times of attempted acquisition.

While high probability of acquisition is predicted even in the event of very crude knowledge of vehicle path, the capability of using more refined sources of target-acquisition data is provided should they be available to further improve early acquisition probability.

In addition to the automatic tracking mode of operation, the eight other modes available at the operating console are:

(1) *Standby*—Equipment is energized and ready for operation. Antenna motion is prevented by brakes on both antenna axes.

(2) *Manual*—The antenna may be manually slewed by use of a "joy stick" control. The slew capability is available in most other modes as well to permit aided tracking, re-positioning of search patterns and other operations.

(3) *Slave*—The antenna may be slaved to either of two external commands at the operator's discretion.

(4) *Search*—Two modes are available, one being a small circular search and the other an azimuth sector search whose angular width is selectable by the operator. These search patterns may be superimposed on the slave commands if desired.

(5) *Auto track*—Unless specifically disabled by the operator, the system will initiate automatic tracking from any active mode any time there is sufficient RF signal strength to exceed the pre-set carrier relay threshold.

(6) *Rate memory*—Upon loss of signal, the antenna will continue driving for a pre-set time interval at angular rates experienced just before loss of signal.

(7) *Carrier relay override*—Automatic tracking with degraded performance is possible at signal levels considerably below the level required to actuate the carrier relay. In this mode, the carrier relay is bypassed, forcing the system to attempt tracking on such level of RF signal as may be available.

(8) *Automatic re-acquisition*—In the event of signal loss, the system will immediately revert to a preferred alternate mode of operation. The alternate modes, in order of preference, are Slave A with circular scan superimposed; Slave B with circular scan superimposed; Rate Memory; and Circular Scan.

If slaving commands are not available in Slave A, the system will automatically try Slave B, and if necessary try in turn Rate Memory and Circular Scan. Should any higher priority mode become available, the system will immediately revert to it. Automatic track has highest priority. The re-acquisition sequence may be disabled or modified at the operator's discretion.

- **Tracking accuracy**—Requirements for tracking accuracy derived from two principal considerations. First, the tracking error should be small enough to result in no significant degradation in the quality of communication. Second, the angle readout error should be small enough to permit accurate determination of vehicle position.

In the first instance, tracking error is primarily determined by the ability of the servo control system to respond to target dynamics. In shipboard applications, of course, ship motion gives rise to additional servo requirements for antenna pedestal motion compensation. In the second case, angle readout error includes mechanical distortions and imperfections in the antenna and ships structure.

Tracking error in RI's system is less than 0.1 degree, with tracking rates up to 10 degrees/sec. and received signal levels higher than 6 db carrier-to-noise ratio in the tracking IF amplifier. Tracking with reduced accuracy is possible at IF carrier-to-noise ratios as low as −5 db to −10 db.

Design specifications for the tracking antenna are for continuous azimuth rotation with velocity up to 31 degrees/sec. and acceleration of up to 200 degrees/sec.[3] Elevation variation is from −18 degrees to 105 degrees with velocity up to 31 degrees/sec. and acceleration of 200 degrees/sec.

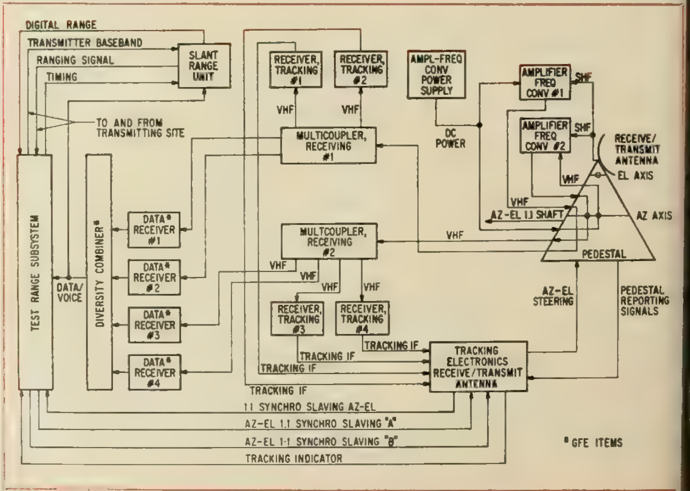
- **Reliability and maintenance**—The critical requirements for prescribed performance during the relatively brief time the vehicle will be within view of a station led to use of reliable modular solid-state circuitry and special test equipment for rapid verification of performance and rapid localization of any equipment malfunctions.

To meet the reliability requirement without duplicate systems, all-transistorized circuitry is used with adequate component de-rating. Predicted MTBF for the tracking system is 400 hr., resulting in a probability in excess of 0.999 that the equipment performance will be adequate during a mission. Additionally, using the availability approach of MTBF and repair cycle time shows that the system is ready for tracking 99.9% of the time.

For maintainability, a special Antenna Test Unit (ATU) is provided as an integral part of the system. This unit, using the go/no-go principle, samples 36 positions, which when in the go condition assures an adequate system. If any position should show no-go, 68 additional positions are available to isolate the smallest removable subassembly. Finally, the ATU has eight self-test positions to determine its adequacy to evaluate the system. ■

RI ENGINEERS check out tracking antenna system for Dyna-Soar flight.

SHF RECEIVING functional schematic for Dyna-Soar Communications and Tracking (CAT) system.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DATA* RECEIVER #3
DATA* RECEIVER #4
RECEIVER, TRACKING #1
RECEIVER, TRACKING #2
VHF
VHF
MULTICOUPLER, RECEIVING #1
AMPL-FREQ CONV POWER SUPPLY
DC POWER
AMPLIFIER FREQ CONV #1
SHF
AMPLIFIER FREQ CONV #2
SHF
RECEIVE/ TRANSMIT ANTENNA
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VHF
AZ-EL 1:1 SHAFT
AZ AXIS
MULTCOUPLER, RECEIVING #2
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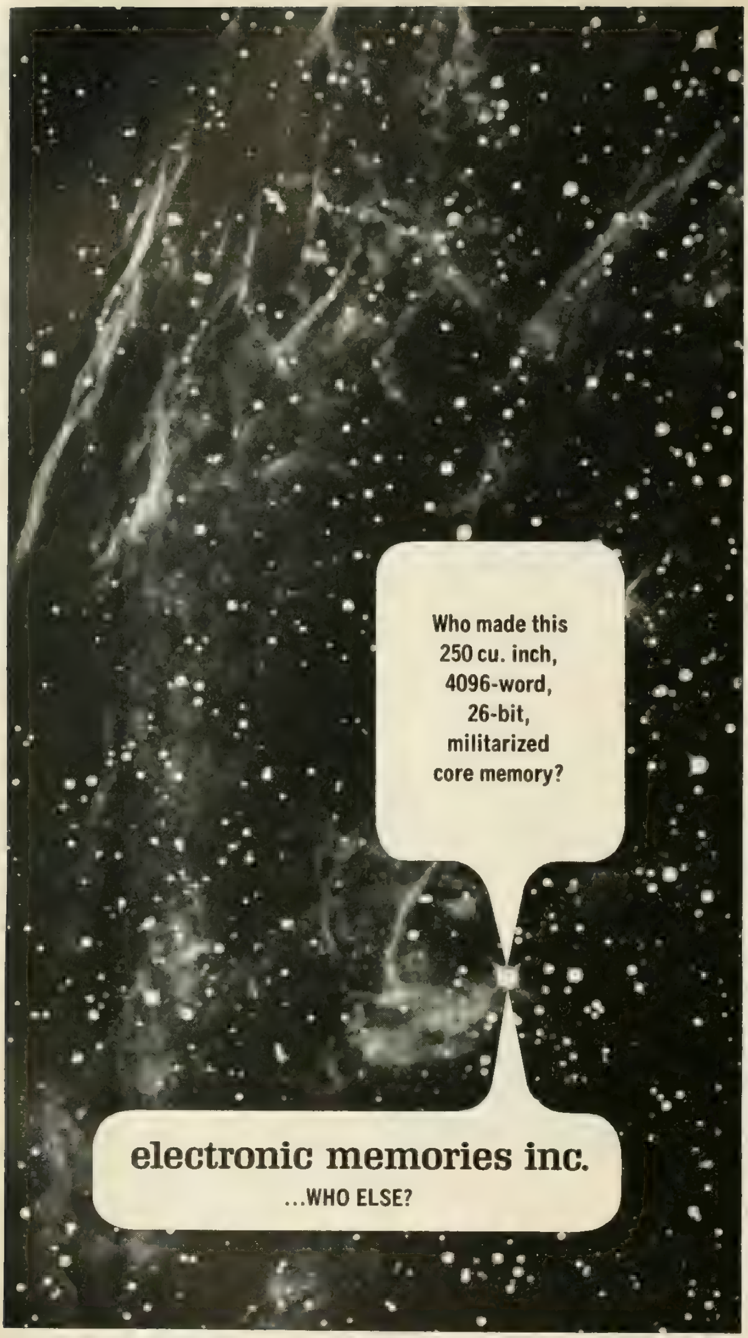
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complexes and ensures that tests are secure against eavesdropping.

The system also makes it possible to conduct simultaneous countdown of two vehicles on adjacent pads from the same blockhouse. Previously, simultaneous countdown of two vehicles to insure that one was launched on time called for the use of two blockhouses.

Air Force spokesmen said the upgrading "is part of our constant program to improve capability at Vandenberg for meeting launch windows, and is not designed to apply to any particular scientific or military mission or program." Demand for use of *Agena* is growing constantly, they said, and the vehicle supports 80% of all Dept. of Defense satellite programs, in addition to many NASA projects. "This improvement means we'll tie up fewer launch facilities and personnel in simultaneous countdowns, while increasing our simultaneous countdown capability."

- **RF system proven**—Details of the new RF checkout equipment were disclosed by K. I. Friedman and E. Stell of LMSC. Included in the system is recording capability for FM/FM telemetry video storage. Primary function of this magnetic tape system is to store telemetry while the telemetry receiving equipment is receiving other telemetry data.

The first pad to be equipped with the closed-loop system has performed satisfactorily in a number of firings.

A solid outer-conductor coaxial cable connects each pad to the blockhouse complex and also interconnects blockhouses. Cable lengths range in length from 1,500 to 2,500 ft. Multiplexing of the vehicle's RF signals is performed by a unit at the top of the umbilical mast, where the combined signals are fed into the coaxial cable.

Present frequencies being transmitted over the cable are 220-260 mc (telemetry) and 2,500-3,000 mc (beacon and command signals). The frequency bandwidth of the long transmission lines restricts the use of this type of system to frequencies below that at which waveguides become desirable.

To verify the functioning of the S-band tracking and command system, S-band signals are sent along the cable from the blockhouse to the vehicle.

The vehicle command system is functionally separate from the vehicle tracking beacon, although the commands and beacon integration are impressed on the same RF carrier.

Time-based modulation of two audio tones provides the command message. A command pulse is interposed between two beacon pulses and has a frequency of displacement equal to the frequency of the combined audio tones. The three basic pulses are amplitude-modulated on the S-band carrier as RF energy.

The vehicle beacon system measures the elapsed time between pulses. When it detects that the time interval corresponds to that of a beacon-pulse pair, it sends back a reply pulse on a different frequency. From this the desired tracking information is obtained.

- **Future manned AGE requirements**—A single, integrated, automatic operational launch control and checkout system which can satisfy multi-mission requirements for manned spacecraft was described by L. S. Klivans and A. D. Slor of LMSC. Such a system appears necessary because the first operational spacecraft is likely to be a multiple-purpose vehicle capable of performing either training, intercept, rescue or reconnaissance missions.

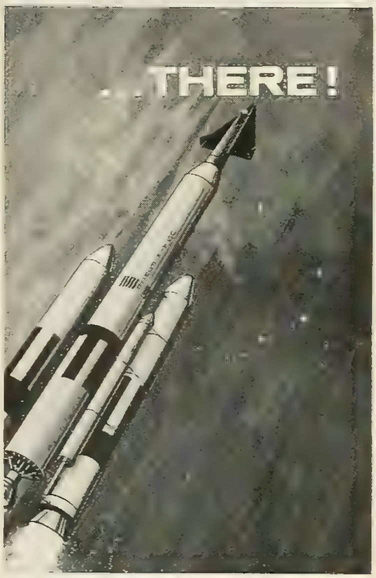
All but training missions will require small launch windows—rescue, intercept, rendezvous with dead satellites where launch window must be short to avoid unnecessary fuel consumption in orbit, and reconnaissance where it is necessary to launch quickly to avoid destruction or where systematic reconnaissance, based on multi-vehicle capability, is desired. In the latter case, the first vehicle launch is not critical, but it fixes all subsequent launch times, as in the case of achieving optimum coverage in polar orbits.

Since the rescue mission sets the requirement that a manned operational spacecraft carry at least two persons, *Gemini* was chosen as a generic model in the NASA-LMSC Aerospace Ground Equipment study.

The system, which would use existing high-speed, general-purpose digital computers and proven techniques, postulates a dual launch base on which two vehicles would be counted down simultaneously, with priority assigned to one craft, to increase probability of getting a flight off on time.

To allow many operational missions, the study recommended a number of dual-pad bases all connected into an integrated communication net. To minimize operational base costs, the engineers reported, a remote launch concept is visualized in which control and response data is handled digitally and can be transmitted 10-30 mi. or more to an AGE command center. This method would obviate the need for blockhouses for each dual pad and make possible time sharing of AGE at he command center.

The system would have application hrough the complete factory-to-launch cycle. There would be essentially identical equipment at factory, field, launch pad, and world-wide tracking and control stations to achieve consistent performance verification, minimize logistic support and simplify training requirements. ■



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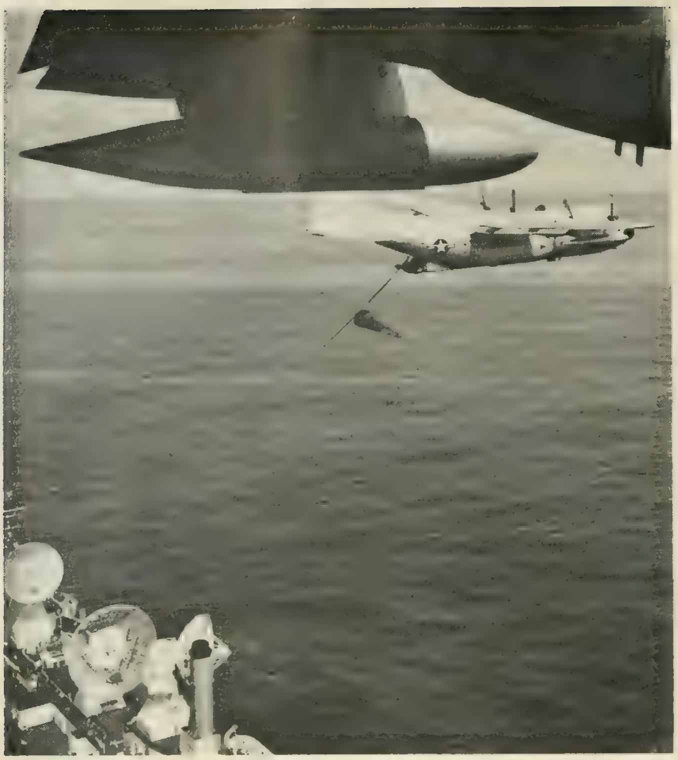


FIRST successful ship-to-air data recovery operation. C-130 over mid-Atlantic Oct. 2 retrieves capsule from USAFS Arnold.

DATA CAPSULE was kicked from low-flying C-130 to test effect of impact into water 200 ft. below. Casing was cracked, but tapes dry.

space support

Air-Snatch Technique Speeds Data Acquisition at AMR

Cape Canaveral—The technique of recovering parachuting space capsules in mid-air, which was perfected in the Pacific area off Vandenberg AFB, is being used on the Atlantic Missile Range to speed return of taped telemetry data from tracking ships to the mainland.

In the past, data tapes were off-loaded when tracking ships put into ports where air transportation was available to the Air Force Missile Test Center, Patrick AFB, Fla.

The newer system cuts several days off the time between acquisition of data on the tracking ships and final reduction in the AFMTC technical laboratory.

First use of the new method came on Oct. 2 when a C-130 cargo plane snatched a balloon target floating above the USAFS Gen. H. H. Arnold, which was on station about 285 miles east of Antigua. The plane crossed the ship at 250-ft. altitude and a trailing boom engaged and broke the balloon.

The watertight, glass fiber capsule developed by Pan American Airways engineers at AFMTC was pulled from the Arnold's deck and reeled into the plane.

The capsule, which resembles a missile re-entry body, is filled with styrene foam to insure buoyancy if it accidentally falls in the water. It has survived many water impact tests run before actual use.

The initial capsule retrieved from the ship contained telemetry tapes recorded Oct. 1 during the flight a submarine-launched *Polaris* missi Also in the capsule was a small pac age of letters men on the Arnold h written to their families.

Range ships are presently being r supplied with data capsules by par chute drop. The capsules impact water near the ship and are retriev by men in small boats. Some of t capsules have contained small, critic parts for onboard equipment.

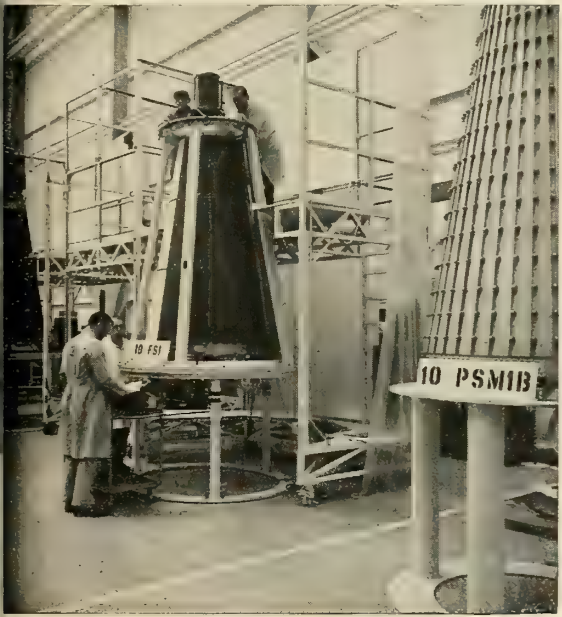
The Air Force has not yet announc how extensively the system will be a plied but it is expected to be operation on the Arnold and the USAFS Ge Hoyt Vandenberg when the ships nally go on station in the Atlantic a Indian Oceans.

CHALLENGE IN SPACE

FOR SENIOR TECHNICAL SPECIALISTS:

Compact Nuclear Systems to Power Tomorrow's Spaceways

Life support equipment, navigation instrumentation, experimental devices, all things electrical for man's future space flights can bear the imprint of your talent through advanced nuclear work at Atomics International. If you have 5 to 7 years of aerospace hardware experience, an EE, Physics or ME degree, the challenge of nuclear auxiliary power for space lies squarely before you. Join A.I. now in this vitally important work.



Fabrication of SNAP 10A systems at A.I.

Atomics International is a prime contractor for SNAP nuclear reactor systems for the U.S. Atomic Energy Commission. Responsibilities of the company include the entire SNAP 10A and SNAP 2 systems, as well as the reactor for SNAP 8. These power sources are designed to generate from 500 to 35,000 watts of electricity for a one-year period of unattended operation in space. Already several A.I. SNAP reactors have successfully passed their initial ground operating tests.

For the National Aeronautics and Space Administration, A.I. is studying the uses of compact nuclear power sources on the moon. To be determined: what design modifications would fit SNAP 2 and SNAP 10A for powering instruments and communications equipment on the lunar surface? Also, how could SNAP 8 be adapted to the power needs of a manned lunar base? SNAP applications might include lunar communications stations capable of operating for long periods unattended... perhaps a manned lunar experimental laboratory or astronomical observatory.

If you are interested in these and other rewarding challenges of space, the time for action is now. Opportunities now available in Atomics International's SNAP programs and other advanced nuclear work include the following:

SYSTEMS & CONTROL ANALYSIS — Analysis and simulation of complete nuclear power plants to develop reliable, automatic control and instrument systems to analyze reactor kinetics, dynamics, stability, thermal characteristics and reliability.

STRESS ANALYSIS — Provide stress analysis of compact nuclear power plants for space applications including review of all designs with respect to stresses resulting from thermogradients; transients, static loadings, vibrational and shock loadings.

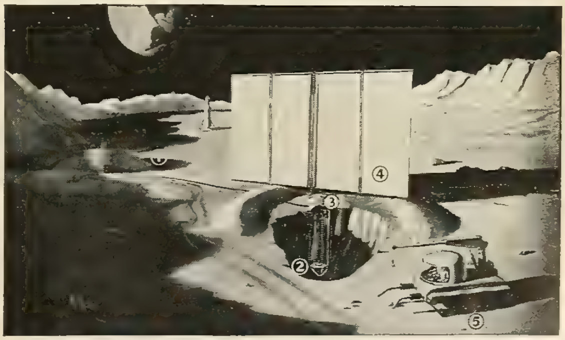
COMPONENT TESTING — Analysis of liquid metal heat transfer components in the SNAP 2/10A systems. Calculations involve knowledge of fluid flow, heat transfer, stress analysis and basic electrical engineering.

ENVIRONMENTAL TESTING — Plan and provide instrumentation for environmental tests of SNAP components and systems primarily for shock, vibration, acceleration, static loading and acoustics.

STRUCTURES — Analyze, investigate and physically test SNAP 2 radiator condensers and test fixtures to determine structural characteristics for launch loads, aerodynamic heating, shock and vibration.

DESIGN — Design high temperature, high reliability nuclear reactor auxiliary systems. Skills required in mechanical design, stress analysis and heat transfer.

Contact: Mr. H. K. Newton
Personnel Office, Atomics International
8900 De Soto Ave.
Canoga Park, California

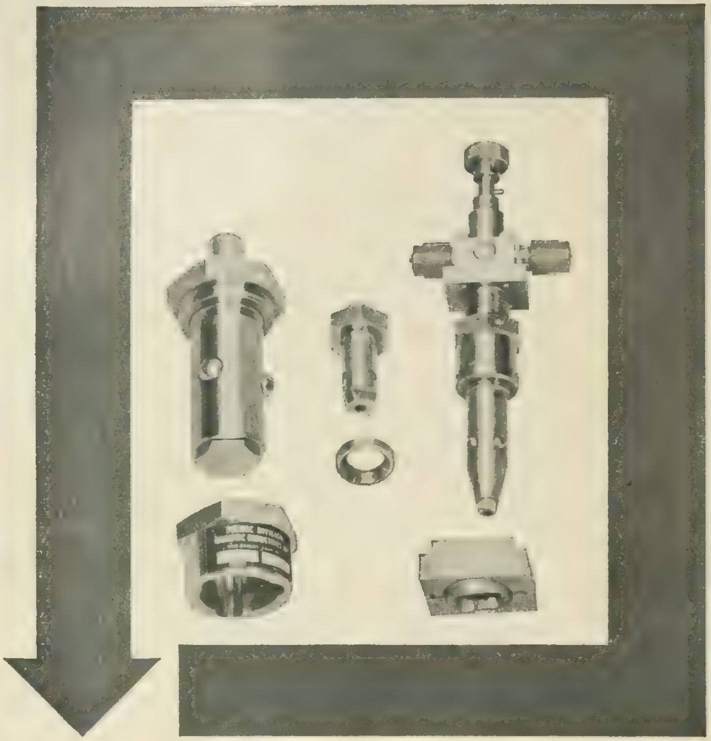


Manned moon base illustrated at (1) would receive its power from SNAP reactor (2) beneath lunar surface. (3) shows power conversion units; (4) is radiator to dispose of excess heat. Roving electrical vehicle (5) would use SNAP power to charge its batteries.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

ATOMICS INTERNATIONAL

DIVISION OF NORTH AMERICAN AVIATION



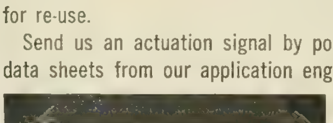
Our bolts are coming apart all over

Some products, when they begin to come apart in mid-air, can be awfully embarrassing. Not ours. They come apart on purpose. And gracefully.

Our Model 1102, for example. It has a record of 100% success in use on the (censored) ICBM re-entry vehicle. When the proper moment comes, it's just "click" and the vehicle sections separate according to program, with no fragmentation, no rupture or tearing of the skin, no release of gases, and no impulse to the separated section.

The Models 1020, 1046, and 1102 pyrotechnically-powered separation bolts shown above are widely used for separation, external stores ejection, and other applications requiring things to fall apart when actuated by an electrical signal. Similar separation bolts may be actuated hydraulically or mechanically. All are fragmentation-free, fast acting, and can be reloaded for re-use.

Send us an actuation signal by postcard and we'll separate some new data sheets from our application engineering department. We'll also send a general brochure on Pelmec separation systems, safing and arming units, and propellant actuated devices.



Pelmec ball-lock separation system used for re-entry vehicle separation.

PELMEC
division of Quantic Industries, Inc.
1015 Commercial Street
San Carlos, California

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book reviews

**THE MEASURE OF THE MOON, Ralph B. Bald
win, The University of Chicago Press, Chicagc
488 pp., $13.50.**

This book is a worthy sequel to th
author's "The Face of the Moon," pub
lished nearly 15 years ago when lunar dat
was far less plentiful. The present book un
doubtedly will become as much a standar
as the earlier one, which was a strong in
fluence in persuading Harold C. Urey
Nobel-prize-winning physicist, to devot
years of serious study to the Moon.

The author notes that even after thou
sands of years of observation of the Moon
and despite an immense amount of dat
derived from space flight, there is no agree
ment about the Moon's shape, surface con
tours, surface materials, the processes tha
have occurred on the body, the nature o
the markings and their ages, the Moon'
history, or the nature of its inner core o
atmosphere. This book is an attempt to giv
the best answers to these questions base
on an exhaustive and penetrating analysi

**PHYSICS AND ASTRONOMY OF THE MOON
edited by Zdenek Kopal, Academic Press, Ne
York, 538 pp., $16.50.**

Anybody wishing to build an adequat
technical library dealing with the Moo
will have to include this book as well as a
earlier one written by the same author, bu
on a less technical level—"The Moon: Ou
Nearest Celestial Neighbor," $4.50 als
Academic Press.

The current book brings together th
foremost lunar exponents writing out
their special knowledge on a fully scientifi
level. Taken together, the work is a com
prehensive picture of today's theories abou
the Moon. It also indicates what the blan
spaces are.

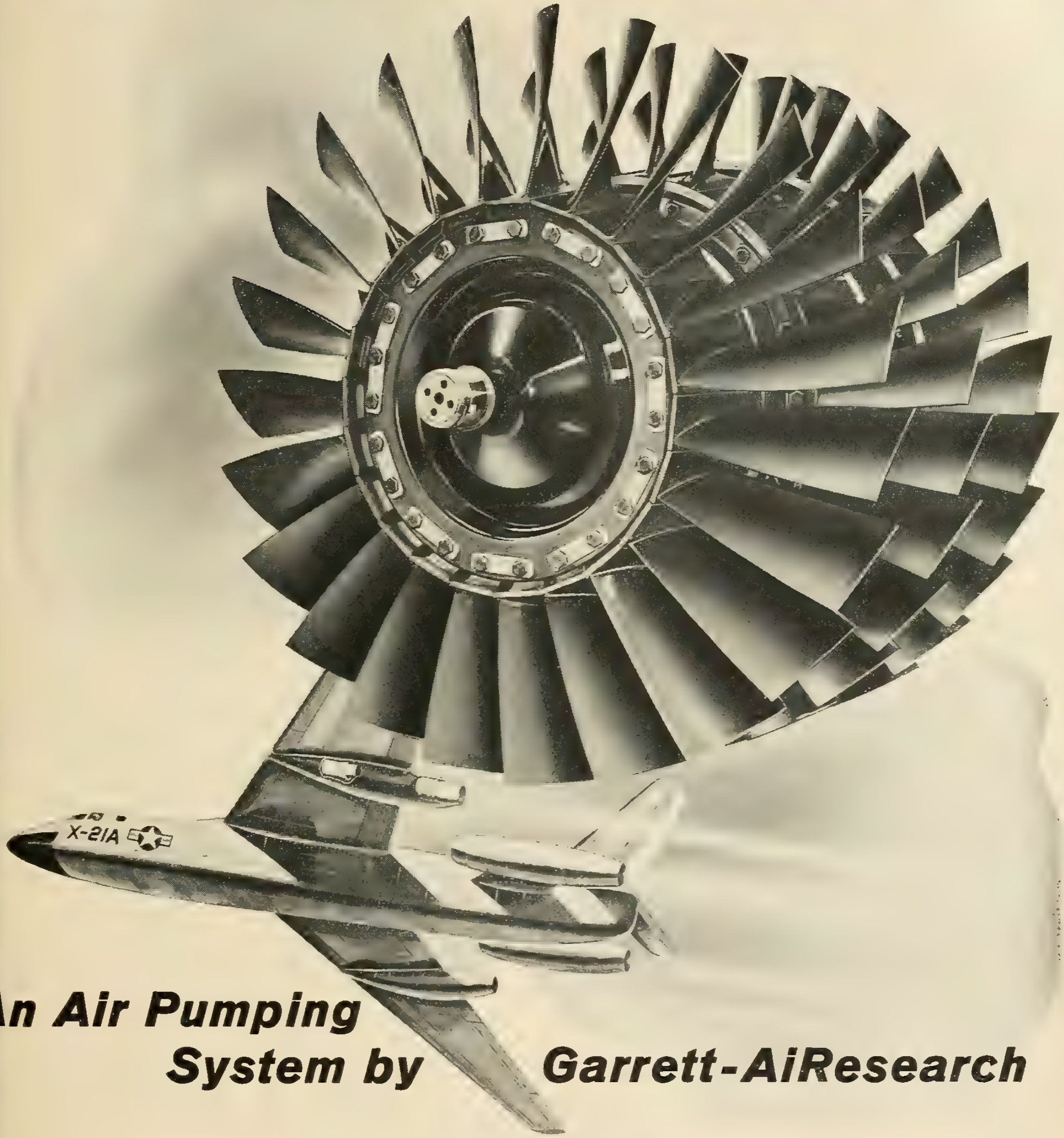
Chapters and authors: The Motions
the Moon in Space, Dirk Brouwer and Ge
Ichior Hori; Liberation of the Moon, Kar
Koziel; Dynamics of the Earth-Moon Sy
tem, Gordon W. Groves; Photometry
the Moon, V. G. Fessenkov; Polarizatio
of Moonlight, Audouin Dollfus; Lun
Eclipses, Frantisek Link; Topography
the Moon, Zdenek Kopal; Interpretation
Lunar Craters, Eugene M. Shoemake
Physical Observations of the Lunar Su
faces, N. A. Kozyrev; Luminescence of th
Lunar Surface, J. F. Grainger and J. Rin
Temperatures on the Lunar Surface, Wi
liam M. Sinton; Radio Echo Studies of th
Moon, J. V. Evans; Origin and History
the Moon, Harold C. Urey.

**MOON EXPLORATIONS: Special Bibliograph
Index, Nina Holt Bradshaw et al, Technical
formation Service, 432 Woodward Bldg., Wa
ington 5, D.C., 252 pp., $40.**

Here is an excellent bibliography of th
leading reports dealing with the Moon a
lunar probes, selected from literature
U.S. Government Research Reports a
covering the period from June, 195
through October, 1962. The content a
cross-indexing would be difficult to i
prove upon.

W.

What is the Heart of LFC?



An Air Pumping System by Garrett-AiResearch

Northrop's success with the X-21A marks an aeronautical breakthrough. Laminar Flow Control may well become a standard feature of long endurance aircraft. The Garrett-AiResearch pumping system on the X-21A sucks turbulent boundary layer air from the wing's surface, eliminating friction drag and substantially increasing range, payload capacity or flight endurance.

This lightweight, reliable and efficient pumping system is a result of Garrett's unmatched experience in compressors, turbines, combustors and controls. Garrett has total capability and flexibility in design, development and production of air pumping systems to match any engine requirement.

If you have an air moving problem in the areas of LFC, BLC, V/STOL, GEM or other specialized lift-fan or pumping systems, write to Garrett-AiResearch, Phoenix.

GARRETT

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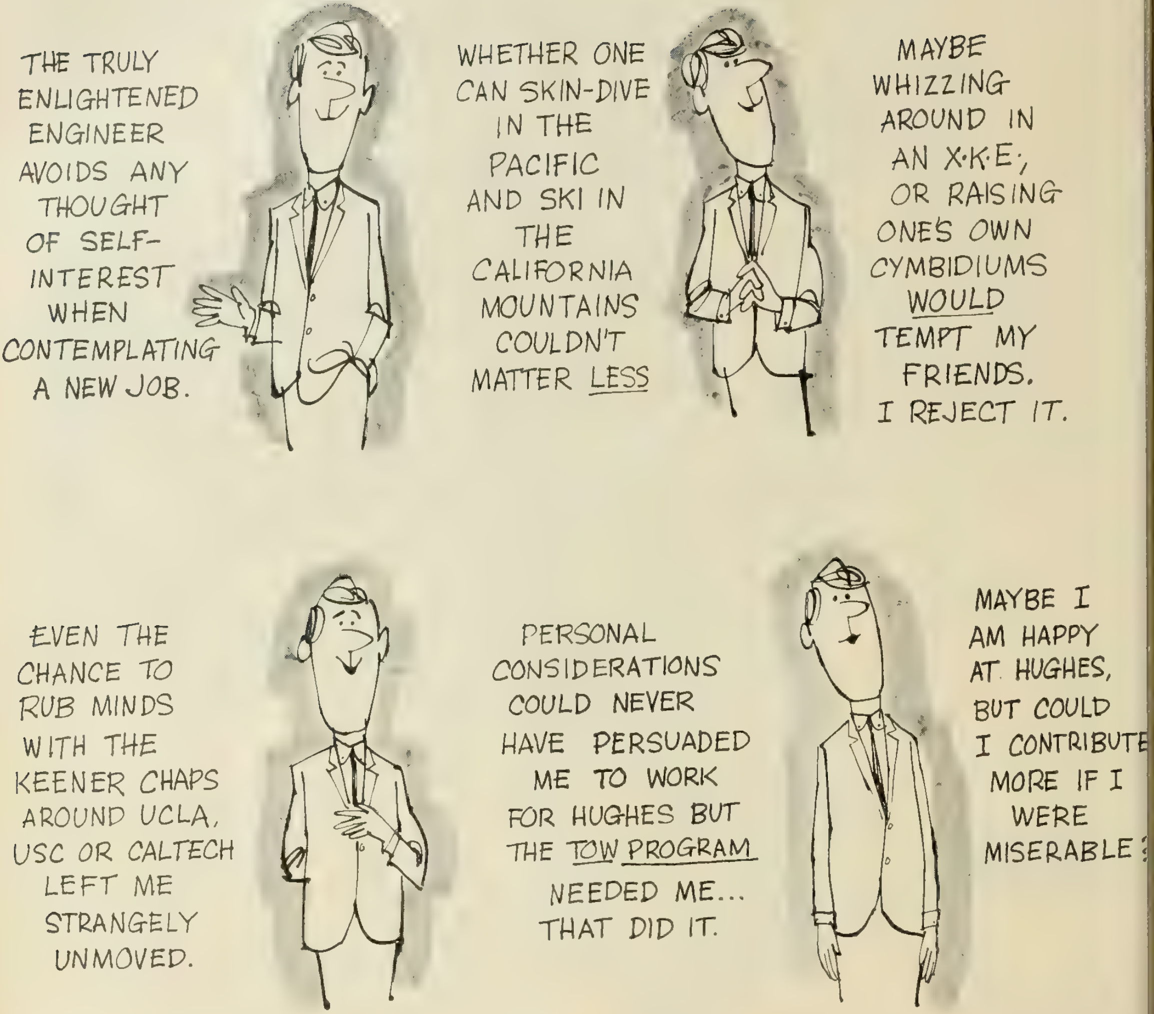
THE TRULY ENLIGHTENED ENGINEER AVOIDS ANY THOUGHT OF SELF-INTEREST WHEN CONTEMPLATING A NEW JOB.
WHETHER ONE CAN SKIN-DIVE IN THE PACIFIC AND SKI IN THE CALIFORNIA MOUNTAINS COULDN'T MATTER LESS
MAYBE WHIZZING AROUND IN AN X·K·E, OR RAISING ONE'S OWN CYMBIDIUMS WOULD TEMPT MY FRIENDS. I REJECT IT.
EVEN THE CHANCE TO RUB MINDS WITH THE KEENER CHAPS AROUND UCLA, USC OR CALTECH LEFT ME STRANGELY UNMOVED.
PERSONAL CONSIDERATIONS COULD NEVER HAVE PERSUADED ME TO WORK FOR HUGHES BUT THE TOW PROGRAM NEEDED ME... THAT DID IT.
MAYBE I AM HAPPY AT HUGHES, BUT COULD I CONTRIBUTE MORE IF I WERE MISERABLE

Hughes is hiring! Numerous opportunities now exist on a variety of advanced projects and studies. For example: **F-111B PHOENIX** Guided Missile System, **TOW** Anti-Tank Missile, **SURVEYOR** Lunar Spacecraft, **SYNCOM** Communications Satellite, **ARPAT,** Advanced **POLARIS** Guidance, **VATE** Versatile Automatic Test Equipment, Hard Point Defense Systems and others. Positions are open for experienced specialists with accredited degrees and U. S. citizenship.

CONTROLS ENGINEERS. Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, control systems, control techniques, transistorized equalization networks and control servomechanisms.

CIRCUIT DESIGNERS. Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

INFRARED SPECIALISTS. To perform systems analysis and preliminary design in infrared activities for satellite detection and identification, air-to-air missiles AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.

SYSTEMS ANALYSTS. To consider such basic problems as: requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

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your resume to:

Mr. Robert A. Martin
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 25, California

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Mergers and Acquisitions

The Garrett Corp., Los Angeles, still fighting takeover by Curtis-Wright Corp., has arranged to merge with Signal Oil and Gas Co. in an effort to strengthen its position in the stock battle. Other recent developments in the situation: C-W has raised its offer to buy 700,000 shares of Garrett stock from $50 to $57 per share; Garrett's board of directors has unanimously recommended that Garrett shareholders reject the new C-W offer; C-W has termed its latest offer as final. . . . *Control Data Corp., Minneapolis, has acquired Control Systems Div. of Daystrom, Inc., Murray Hill, N.J. The division, located in La Jolla, Calif., produces industrial computer controls and allied equipment. It will be operated under CDC's industrial group.* . . . A proposal to merge Mandrel Industries, Inc., Menlo Park, Calif., into Ampex Corp. has been approved by directors of both firms. Ampex shareholders will vote on the proposal, calling for 9 shares of Ampex common stock for each 10 shares of Mandrel common, within the next few months. Ampex, Redwood City, Calif., designs and manufactures magnetic recording equipment. Mandrel is a geophysical service organization serving industries concerned with the Earth sciences and other fields. . . . *Cordo Chemical Corp., Norwalk, Conn., has been acquired by Ferro Corp., Cleveland, Ohio, a major supplier of fiberglass, chemical and colorants to the plastic industry. CCC, with plants in Norwalk and Mobile, Ala., will be operated as the Cordo Div. It manufactures plastic coated fiberglass products for the aircraft and missile/space field.* . . . Ilikon Corp., Natick, Mass., a research and development firm, has purchased Middlesex Welding Co., Inc., Somerville, Mass. MWC, producer of metal shells for space simulation vacuum systems, will be operated as a division of Ilikon.

New Firms and Divisions

Ling-Temco-Vought, Inc., Dallas, has discontinued use of the names Chance Vought Corp. and Temco Electronics & Missiles Co. The firm has also renamed 10 divisions. The change is intended to shorten lines of communication and reduce costs through elimination of administrative duplication. . . . *Cyclo-Tronics, Inc., a Chicago-based firm, has been formed to produce and environmentally test advanced electronic assemblies and equipment, including micro-miniature modules.* . . . Condor Industrial, Wheaton, Ill., has been formed to manufacture cable assemblies, wiring harnesses and miscellaneous electronic and electrical devices for military and commercial use. . . . *Video Color Corp., Inglewood, Calif., has formed an industrial tube division to develop, design and manufacture special purpose cathode ray tubes for use in video recording, flying spot scanning, oscilloscopes, radar, monitors, monoscopes, character generators and other special displays.*

In The Courts

Mach-Tronics, Inc., Mountain View, Calif., electronics firm, sued by the Ampex Corp. for patent infringement earlier this year, is now facing charges of infringement, unfair competition and fraud. Mech-Tronics Corp., Melrose Park, Ill., claims that Mach-Tronics is "deliberately misleading customers with whom both companies do business into thinking it is 'Mech' (rather than 'Mach') with whom they are doing business."

Industry Facilities

Martin Co.'s Orlando (Fla.) Div. has opened a new research center. The facility will incorporate six major scientific laboratories for the conduct of both fundamental and applied research. . . . *Electro-Tec Corp., West Caldwell, N.J., manufacturer of precision slip rings, brush blocks, slip ring capsules and military type relays, has announced plans for expansion of its Blacksburg, Va., and Ormond Beach, Fla., plants. The new facilities will afford increased space for engineering design and development.* . . . Barnes Engineering Co. has opened a new plant in Melbourne, Fla. The firm's expanded Range Systems Operation will occupy the building and will devote its effort to research, development and manufacture of electro-optical instruments and completely integrated systems for use on missile ranges. . . . *North American Aviation's Columbus Div. has installed two research devices to evaluate electronic and reconnaissance equipment and control systems under simulated flight conditions, to determine thicknesses and strengths of metals used in advanced aircraft and missile components and to predict their life spans. The two units are a Model C125 vibration exciter, produced by MB Electronics, a division of Textron Electronics, Inc., New Haven, Conn., and a HYGE shock tester made by Consolidated Vacuum Corp., Rochester, N.Y.* . . . Eldorado Electronics has moved into expanded new quarters at Concord, Calif. The 23,000-sq.-ft. plant will enable EE to maintain production commitments on the firm's one-nanosecond Time Interval Counter and related instrumentation while providing space for advanced research projects.

Company Representatives

Anvet Corp., Los Angeles, has been appointed Los Angeles distributor for Thompson Ramo Woolridge, Inc.'s Semiconductors, Inc., and Capacitor Div. . . . *Pedrel, Inc., Palo Alto, Calif., has appointed Ault Associates as sales representatives for their line of automation equipment. AA, with offices in Menlo Park and Inglewood, Calif., will handle Pedrel products in California, Nevada and Arizona.* . . . R.A. Banks Co., Los Altos, Calif., has been appointed by Korry Manufacturing Co., Seattle, Wash., as sales representative for northern California and northern Nevada. Banks will handle Korry's line of pilot lights, indicators, switch lights and switching keyboards.

AIR FORCE

$10,000,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued research and development on *Minuteman* ICBM Stage II motors.

$10,000,000—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for guidance and control systems for the *Minuteman* ICBM.

$5,000,000—**General Electric Co., Missiles & Space Vehicles Div.,** Philadelphia, for research and development of a new missile re-entry system.

$4,100,000—**UAC, Corporate Systems Center,** Farmington, Conn., for development work related to furthering weather analysis and forecasting techniques.

$2,300,000—**Collins Radio Co.,** Dallas, for production of a high-frequency antenna for space application.

$2,200,000—**Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for continued satellite research work on control problems.

$650,000—**Bendix Corp.,** North Hollywood, Calif., for provision of the power supply and thrust-vector-control system for the acceleration rocket of the *X-20 Dyna-Soar* spacecraft.

$624,280—**Space General Corp.,** El Monte, Calif., for *Aerobee 150* sounding rockets and associated components.

$515,000—**Boeing Co.,** Seattle, for engineering services applicable to the *Minuteman* weapon system.

$350,000—**Raytheon Co., Space and Information Systems Div.,** Bedford, Mass., for a 12-month study of rendezvous techniques and components to be used during space missions.

$328,000—**TRW Space Technology Laboratories,** Redondo Beach, Calif., for engineering services applicable to the *Minuteman* weapon system.

$154,000—**Atlantic Research Corp., Missile Systems Div.,** Arcadia, Calif., for research, plus field launch services, for the *Trailblazer II* rocket system. Work to be performed at Duarte, Calif.

$150,000—**Ohio State University Research Foundation,** Columbus, for services in support of research on the chemistry of fuel and propulsion.

$100,000—**Raytheon Co., Space and Information Systems Div.,** Bedford, Mass., for the preliminary design of a forward looking radar for use in navigation, target recognition and weapon delivery.

$78,116—**Aerolab Development Co.,** Monrovia, Calif., for *Cajun* rocket fins.

$73,934—**Hallicrafters Co.,** Chicago, Ill., for aerospace ground equipment items for AN/ALT-13, 15, 16 electronic countermeasures.

$41,880—**Atlantic Research Corp., Missile Systems Div.,** Arcadia, Calif., for *Nike* booster fin assemblies for sounding rocket research. Work to be performed at Duarte, Calif.

$41,081—**Sage Laboratories, Inc.,** Natick, Mass., for ground-to-vehicle instrumentation components for the *Titan III.*

$39,932—**Block Engineering, Inc.,** Cambridge, Mass., for studies to establish capabilities for a velocity spectrograph.

$34,664—**Block Engineering, Inc.,** Cambridge, Mass., for studies and evaluation of a folding interferometer for space data acquisition.

ARMY

$1,500,000—**Radiation, Inc.,** Melbourne, Fla., for electronics equipment.

$817,786—**Stanford Research Institute,** Menlo Park, Calif., for a study of *Nike-Zeus* missile capabilities.

$77,935—**Hayes International Corp.,** Birmingham, Ala., for *Pershing* missile trainer repair parts.

$74,862—**Space, Inc.,** Huntsville, Ala., for all services, personnel, etc. related to production of 200 sets of Micom-40 experimental rocket parts.

$39,273—**Telecomputing Corp.,** North Hollywood, Calif., for film digitizing system.

NAVY

$2,900,000—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for navigation equipment (SINS) repair and modifications.

$1,600,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Great Neck, N.Y., for gyros.

$1,000,000—**Bendix Corp., Radio Div.,** Towson, Md., for a mobile all-weather missile range safety system.

$694,201—**Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for an engineering effort to support a Naval weapons annex and *Polaris* missile facility.

$413,000—**Dorsett Electronics, Inc.,** Tulsa, Okla., for delivery of telemetry equipment (2 contracts).

$301,560—**Lasko Metal Products, Inc.,** West Chester, Pa., for shipping and storage containers for *MK33* guided missiles.

$100,000—**Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for *A3 Polaris* missile containers for components only.

$96,750—**Atlantic Research Corp.,** Alexandria, Va., for replacement of equipment covering production of solid propellant motors for military missiles.

$95,500—**Stanford Research Institute,** Menlo Park, Calif., for solid propellant research and development with emphasis on the areas of viscoelastic properties of solid propellants.

$83,690—**Radio Corp. of America, RCA Laboratories Div.,** Princeton, N.J., for studies of intelligence exchange requirements for advanced sea-based deterrent weapon systems.

$81,164—**Servomechanisms, Inc.,** El Segundo, Calif., for computer assemblies.

$66,561—**General Electric Co.,** Santa Barbara, Calif., for a study of a general cost model developed for the advanced sea-based deterrent systems.

$36,206—**General Electric Co., Light Military Electronics Dept.,** Utica, N.Y., for test missiles.

$11,087—**Hercules Powder Co.,** Wilmington, Del., for research and development on solid propellants.

General Motors Corp., AC Sparkplug Div., Milwaukee, Wis., for provision of modifications to accelerometers for the MK 2 *Polaris* guidance systems (undisclosed amount).

NASA

$2,000,000—**Lockheed Missiles & Space Co.,** Van Nuys, Calif., for development of a vehicle systems test complex for *Agena-Gemini* system checkout.

$1,000,000—**Martin Co.,** Baltimore, for further *Nova* studies.

$450,000—**Textron Electronics Spectrolab Div.,** Sylmar, Calif., for the design and development of a radiative heating system for use in re-entry simulation studies.

$416,057—**Radio Corp. of America, Electronic Tube Div.,** Lancaster, Pa., for N-on-P solar cells.

$194,600—**Texas Instruments, Inc.,** Dallas, for a study to determine optimum measurements, experiments and geologic studies to be made on the lunar surface.

$183,152—**Wyle Laboratories,** Huntsville, Ala., fo a high-intensity acoustic facility.

$178,572—**Farrand Optical Co., Inc.,** New York City, for an advanced infinity display system

$167,400—**RCA Victor Co., Ltd.,** Montreal, fo *Syncom II* FM and PM receivers.

$125,000—**Carco Electronics,** Menlo Park, Calif. for a three-axis flight servo table.

$120,000—**Geophysics Corp. of America,** Bedford Mass., for a sodium vapor experiment.

$117,900—**International Latex Corp.,** Dover, Del. for pressure garment assemblies.

$99,973—**Bendix Corp., Bendix Products Aerospace Div.,** South Bend, Ind., for a study of energy absorbing characteristics of crushable aluminum structures in a space environment

$99,830—**Systems Engineering Laboratories, Inc.** Fort Lauderdale, Fla., for a portable, digital data-recording system.

$99,000—**Chance-Vought Astronautics of L-T-V Inc.,** Dallas, for a *Gemini* launch-vehicle training program.

$97,450—**Hughes Aircraft Co.,** Culver City, Calif. for a study of spacecraft antenna systems.

$92,619—**Electronic Communications, Inc.,** St Petersburg, Fla., for design and fabrication o a mobile communication terminal for relay o control data to spacecraft in flight.

$88,836—**Minnesota Mining and Manufacturin Co., Mincom Div.,** Los Angeles, for a recorde reproducer.

$83,515—**IBM Corp., Federal Systems Div.,** Bethesda, Md., for design and fabrication of a optical communications system for an Earth-orbiting spacecraft.

$81,020—**Ling-Temco-Vought, Inc., Electronic Div.,** Anaheim, Calif., for a 3,000-lb.-forc electrodynamic shaker system.

$76,000—**Bell Aerospace Corp., Bell Aerosystem Co.,** Buffalo, N.Y., for an electronic imag generator and associated equipment.

$68,717—**United Aircraft Corp., Hamilton Standard Div.,** Windsor Locks, Conn., for an engineering study and preliminary design of a one man propulsion device for lunar and free space environments.

$68,314—**General Electric Co., Missiles & Spac Vehicles Div.,** Philadelphia, for a study program of the degradation of ablators.

$66,725—**Computer Products, Inc.,** South Belmer N.J., for an analog computer system.

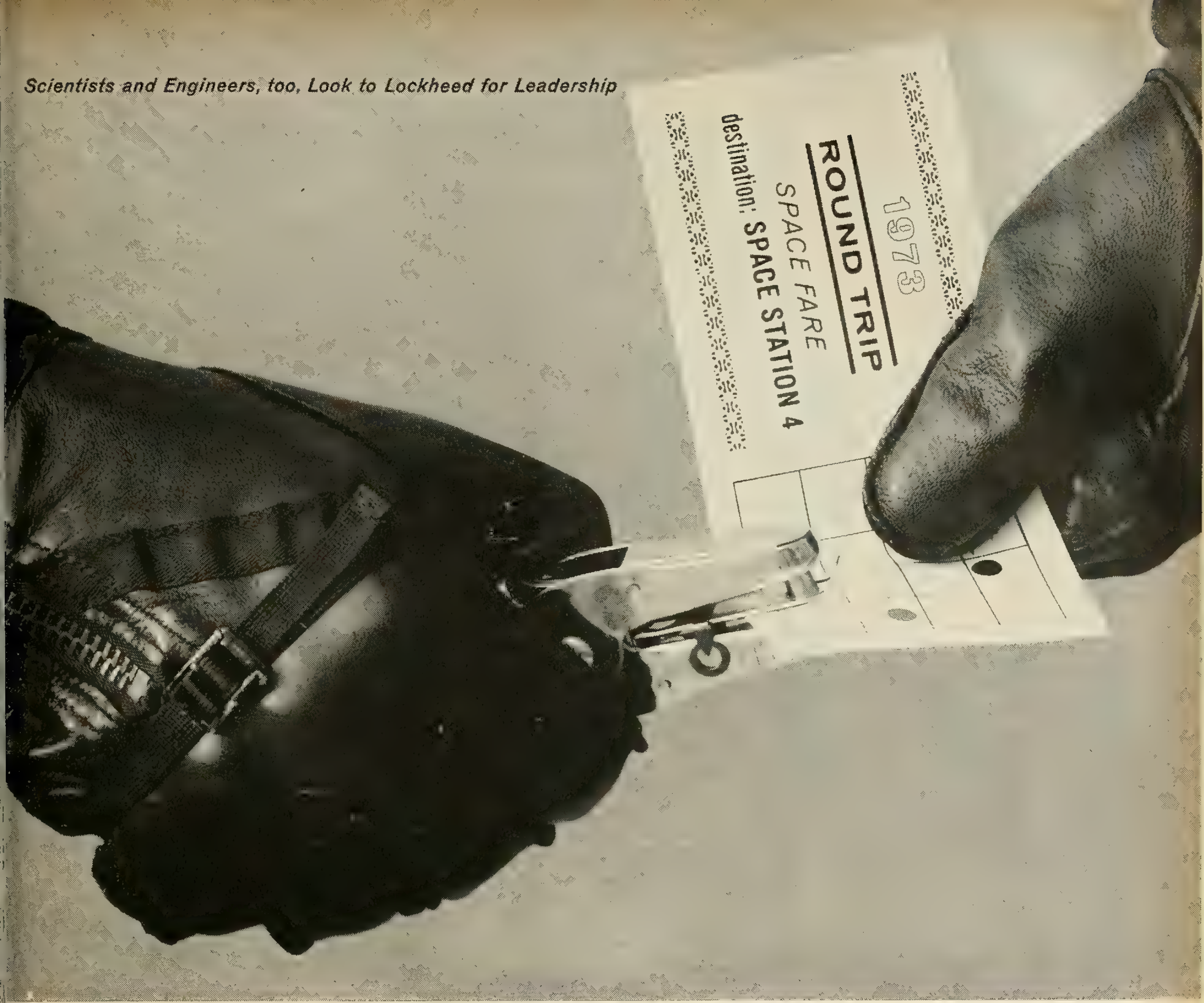
INDUSTRY

$1,650,000—**Fairchild Stratos Corp., Space System Div.,** Rockville, Md., from the **Martin Co.,** fo a standard payload fairing that will protec payloads atop the *Titan III* standard spac launch vehicle.

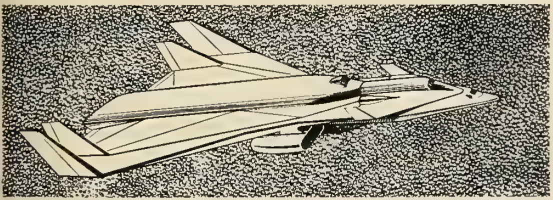
$203,000—**McCormick Selph Associates,** Holliste Calif., from the **Denver Div. of Martin Marietta Corp.,** for the continued production o M-100 pressure cartridges used in the *Tita II* and *III* standard space launch system.

$41,081—**Sage Laboratories, Inc.,** Natick, Mass. from **Martin Co.'s Denver Div.,** for production of vital ground-to-vehicle instrumentatio components for the *Titan III* standard spac launch vehicle.

Scientists and Engineers, too, Look to Lockheed for Leadership



destination: SPACE STATION 4



Problem: How do you carry ten passengers, two crewmen, three tons of cargo to a space station in low earth orbit—then carry them back—and still approach the passenger safety level of today's commercial aircraft?

Solution: By 1973, a rocket plane under a NASA study by Lockheed-California engineers will do the job. Cost for a round-trip ticket? $25,000 to $50,000.

This 18,000-mph reusable cargo carrier will have two to three "nested" stages. The first will be turbojet-powered for atmospheric return to home base. Both second and third (passenger carrier) will be glide vehicles. A winged craft, it will take off horizontally with the help of a ground accelerator and, on return to earth, make aircraft-type landings.

With an estimated life of 10 years, the operational cost of the fully recoverable system (based on 16 missions per month) would be less than $100 million annually—whereas the use of expendable boosters would be $2 billion a year. This shuttle spacecraft will resupply space stations, rotate personnel, and serve as a link in support of lunar bases and early manned planetary expeditions.

SCIENTISTS AND ENGINEERS: Projects like these in Spacecraft; studies in Antisubmarine Warfare and Ocean Systems; work on America's supersonic transport in Advanced Aircraft—all add up to an exciting future for Lockheed-California. Why not make it your future, too?

Write: Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1710, 2405 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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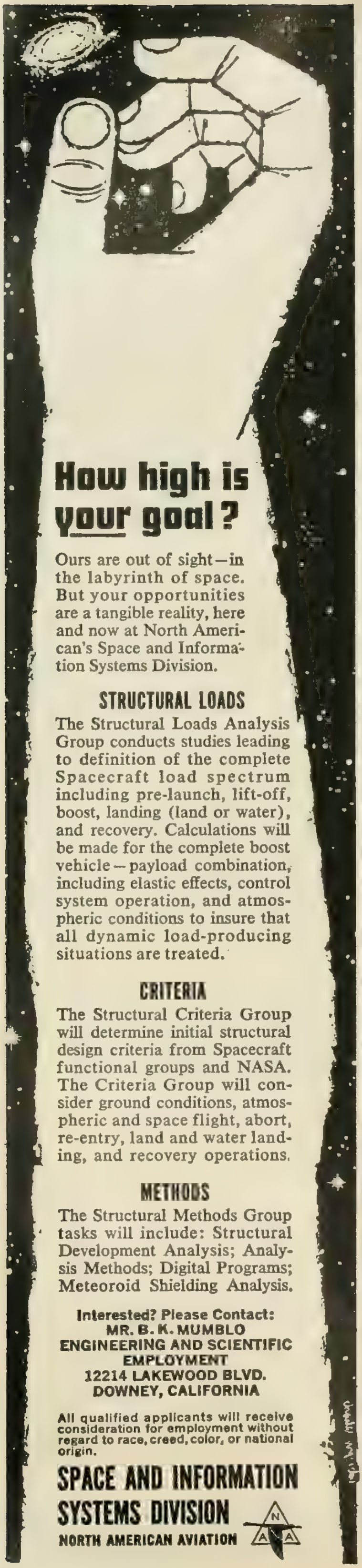

How high is your goal?

Ours are out of sight—in the labyrinth of space. But your opportunities are a tangible reality, here and now at North American's Space and Information Systems Division.

STRUCTURAL LOADS

The Structural Loads Analysis Group conducts studies leading to definition of the complete Spacecraft load spectrum including pre-launch, lift-off, boost, landing (land or water), and recovery. Calculations will be made for the complete boost vehicle—payload combination, including elastic effects, control system operation, and atmospheric conditions to insure that all dynamic load-producing situations are treated.

CRITERIA

The Structural Criteria Group will determine initial structural design criteria from Spacecraft functional groups and NASA. The Criteria Group will consider ground conditions, atmospheric and space flight, abort, re-entry, land and water landing, and recovery operations.

METHODS

The Structural Methods Group tasks will include: Structural Development Analysis; Analysis Methods; Digital Programs; Meteoroid Shielding Analysis.

Interested? Please Contact:
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ENGINEERING AND SCIENTIFIC EMPLOYMENT
12214 LAKEWOOD BLVD.
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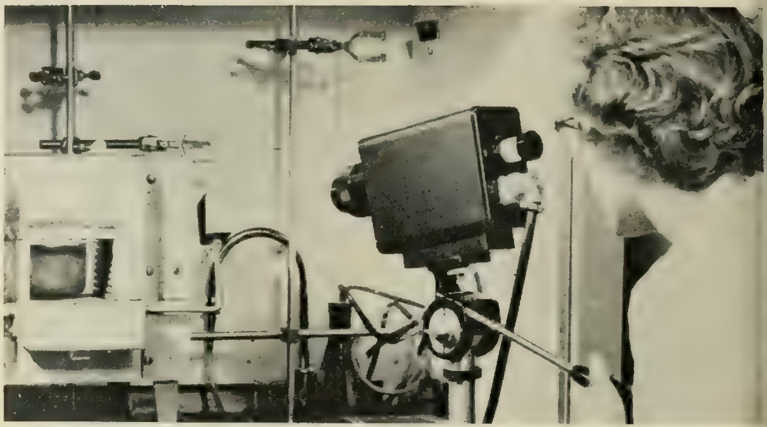
SPACE AND INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION



New Product of the Week:

Radiation Thermometer

Infrared Industries, Inc., has developed the Model TD-8, a non-contact, electro-optical radiation thermometer.

Temperature range is 150° to 2,500°F. Range of focus is accurate from 20 inches to infinity. The device can measure a spot as small as 0.25 in. with an accuracy to within 2%. With speeds from 50 to 500 milliseconds, the unit has a response time to 95% of full scale. Recorder output is 0 to 10 mv dc.

Circle No. 225 on Subscriber Service Card

Chopper Transformer

United Transformer Corp. has available the Model H-295 chopper transformer which meets MIL-T-27B specifications.

The unit has a range of 60 to 400 cps. One-half primary impedance is 10k/2.5k ohms; secondary impedance is 50k ohms. Maximum voltage ½ primary: 60 cps 4/2, 400 cps 24/12. Minimum primary inductance at 1 v 60 cps is 200/50 Hys. Primary resistance is 1,300/650 ohms; secondary resistance is 1,900 ohms.

Circle No. 226 on Subscriber Service Card

Logarithmic Amplifier

Kay Electric Co. has available the Logafier 1025A, a logarithmic amplifier with coverage from 200 kc to 220 mc.

The unit provides an 80-db dynamic range at 0.5-v input and is available as a calibrated oscilloscope display or as a built-in panel meter indication. Three logarithmic ranges are provided—full scale, 40 db, 60 db or 80 db.

Other specifications: flatness—0.5 to 100 mc, ±0.5 db; 200 kc to 220 mc, ±1.0 db; accuracy—±1.5 db; expand control—variable over 0 to 7.0-db range; input impedance 50 ohms; output impedance—50 ohms.

Circle No. 227 on Subscriber Service Card

Voltage Detector

Regent Controls, Inc., has available an automatic transient voltage detector, the Model TD763. In operation, any voltage exceeding a pre-selected level causes a one-step advance of the instrument's linear dial to the next higher level.

The device has 0.5-μsec pulse response. Accuracy is ±2% for pulses with durations of 0.5 μsec to dc.

Attenuator probes are available for the following voltage ranges: 0 to 5v, 20v, 200v, 2kv, 10kv, 20kv and 40 kv. A front-panel switch enables selection of a high or low range for each probe.

Circle No. 228 on Subscriber Service Card

Solid-State Transmitter

A 2-watt minimum environmentalized solid-state transmitter, the Type 1062, is being marketed by Tele-Dynamics Div., of American Bosch Arma Corp.

The crystal-stabilized FM unit covers the 215 to 260-mc telemetry band. It operates in temperatures up to 85°C vibration levels of 15g, shock, 100g, and acceleration of 60g.

The device has a nine-pin connector and an RF output connector. It meets MIL-I-26600 specifications.

Circle No. 229 on Subscriber Service Card

This Target Intercept Computer controls the Nike-Zeus anti-missiles launched from Kwajalein Island

Quick! What company makes it?

The men at the United States Army Materiel Command can tell you: UNIVAC.

They can tell you because of the ICBM-boosted targets that the Nike-Zeus missiles have intercepted so successfully. How is it done? The Target Intercept Computer designed and built by UNIVAC for Bell Telephone Laboratories, predicts an intercept point, based on the constant updating of the ICBM's current speed and position in space. It initiates the launch order for the Nike-Zeus, issues steering orders to keep Zeus on an intercept trajectory, instructs Zeus at the precise time to "burst" and "destroy" the target and then calculates intercept accuracy data since neither missile carries a live warhead in this test program. And because both missiles travel at such great speeds, the UNIVAC® Target Intercept Computer is required to perform at least 165,000 computations per second.

UNIVAC has been part of the NIKE-ZEUS Program since its inception. The profound experience in ballistic-missile defense systems is today concentrated on the design and development of guidance and control functions for the recently authorized Nike-X anti-missile missile system now under development.

Unusual? Uncommon? Not if you know UNIVAC.

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Circle No. 20 on Subscriber Service Card

Engineering Spectaculars – Fact, not Fiction at Bell Aerosystems . . .

In the technical community, what sort of programs warrant the designation "spectacular"? Here are *five* that do, and they're typical of the many unusual engineering challenges at Bell Aerosystems. □ □ □ **the free-flight personal Rocket Belt,** making man's agelong dream of controlled individual flight a reality. Already successfully flight tested for the military, the Rocket Belt is being considered for a variety of new applications. □ □ □ **the Hydroskimmer, SKMR-1,** largest GEM ever built in the U.S., is opening up a new mode of transportation. Designed and built for BuShips, this vehicle skims 1½ feet above water at speeds of more than 70 knots, as well as over land, marsh, and other types of terrain. Navy Phase III operational test program is being conducted on Lake Erie. □ □ □ **LLRV-Lunar Landing Research Vehicles,** which will permit astronauts in training to physically fly a simulated lunar flight. □ □ □ **X-22A, Tri-Service VTOL Jet Transport,** research aircraft in which the propulsion and control elements are utilized during *all* phases of hovering, transition, and conventional flight. Two of the dual-tandem, ducted-propeller aircraft are to be built to explore these concepts for flight characteristics and military potential. □ □ □ **Space Guidance & Control Systems,** for advanced Orbital & Re-entry vehicles with new requirements. These include all aspects of manual and automatically controlled energy management. □ □ □ If you are interested in applying your vision and skill to outstanding innovations in engineering history, look into these opportunities with Bell Aerosystems:

SYSTEMS ENGINEERS For technical direction of systems aspects of advanced R&D programs, including all aspects of the dynamics, flight control, and guidance of aerospace vehicles. Prefer MS in Engineering and 7 to 10 years applicable experience. **Salary to $18,800.**

PROJECT ENGINEER–GEM VEHICLES To assume technical direction of GEM R&D programs. Must be capable of integrating analytical data from all engineering and scientific disciplines. BS AE degree and related project aircraft experience required with GEM experience most desirable. **Salary to $15,400.**

SPACE SYSTEMS DEVELOPMENT ENGINEERS To determine requirements and advanced concepts for space vehicles and space propulsion systems through company-funded and contractual advanced design studies. Assignments will include the coordination of activities in the preparation of major proposals, being cognizant of technical approach, scheduling and cost aspects. Successful proposals offer the potential of appointment to technical direction or project engineering responsibilities. BS in Engineering required with advanced degree preferred, and 8 to 15 years experience in system engineering. **Salary to $18,800.**

RAMJET AERODYNAMICIST Technical specialist to perform aero-thermodynamic analyses and plan and conduct tests of ramjet engine systems. Should have experience in complete engine test as well as component systems such as controls. MS or equivalent in AE or ME plus 7 to 10 years applicable experience required. **Salary to $15,400.**

SENIOR STRUCTURES ENGINEER To direct the activities of a small group of structures engineers in design analysis of complex structures, shells and pressure vessels. Work will be oriented toward structural analysis of liquid propellant rocket engines, turbine pumps, thrust chambers, valves and components. Engineering degree with 5 to 10 years of related experience required. **Salary to $15,400.**

PRELIMINARY DESIGN ENGINEER To conduct analytical and design studies in all areas of liquid propellant rocket engines and injector systems. To be responsible for conceptual design and supporting analysis for new rocket propulsion systems. Requires an advanced engineering degree plus 6 to 12 years related experience. **Salary to $18,800.**

Resumes are invited from Engineers qualified for positions in one of the areas listed above. Please address Mr. Thomas Fritschi, Dept. C-39.

ba
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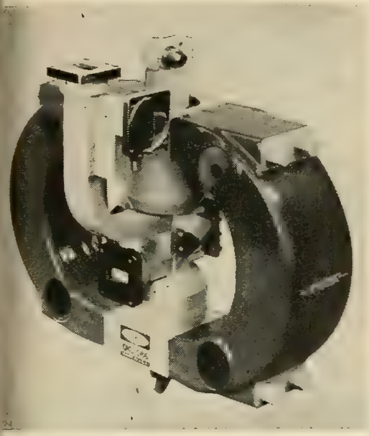
Klystron Amplifier

Raytheon Co.'s Microwave and Power Tube Div. is marketing the Model QKL1066 klystron amplifier operating in the 10.2 to 10.6-gc frequency range.



AM noise level measured in a 1-kc bandwidth from 2 to 20 kc is —115 db below the carrier. Beyond 20 kc, the noise level is —125 db.

Power output is 2,000 watts maximum. The device is tunable and liquid cooled.

Circle No. 230 on Subscriber Service Card

Servo Indicator

The Model CS 106, a servo system indicator with built-in power supply and transistorized amplifier, is being marketed by Control Technology Co., Inc.

Power requirement for the system is 115v, 60 cps or 400 cps line. Overall accuracy is 0.04%, under both static conditions and slowing rates up to 40 degrees/sec.

The unit can be supplied with an auxiliary potentiometer or synchro output. It features radiation-proof transmitters for nuclear environments.

Circle No. 231 on Subscriber Service Card

Amplifier-Demodulator

Natel Engineering Co., Inc., is marketing the Model D6056 Servo Control Amplifier-Demodulator.

The device provides ±40-v dc output for 200-mv RMS input voltage. Input and output impedances are 50k ohms and 600 ohms. Linearity is ±0.5%, with simultaneous supply voltage variations from 25 to 31v dc and temperature excursions from —40° to 80°C. Frequency response is flat within ±3 db from dc to 80 cps with a 400-cps carrier frequency. Output ripple is less than 0.5% of full scale. Quadrature rejection exceeds 100:1 and gain can be varied externally over a 4:1 range.

DC power consumption is 30 ma at 28v with 40v dc output or 12 ma with zero output. Carrier frequencies from 60 cps to 5 kc can be used.

Circle No. 232 on Subscriber Service Card

Pressure Transducer

The Instrument Div. of Bourns, Inc., has available the Model 2320 dc-dc variable reluctance pressure transducer.

The solid-state device operates from unregulated 28-v dc power supplies. Output is 0 to 5v dc. Output impedance is 1,000 ohms maximum. Pressures ranges are 0 to 5 and 0 to 5,000 psia, psig and psid. Terminal-based linearity is ±0.25%. Frequency response is flat 0 to 700 cps.

Circle No. 233 on Subscriber Service Card

Power Supply

Kepco, Inc., has available the Model ABC 1000M power supply with a voltage range up to 1,000v. The supply is variable from zero v and at currents up to 20 ma.

Specifications include 0.05% line and load voltage regulation; 50 microsecond recovery time; output impedance of 25 ohms to 100 cps; 1,000-v isolation and a dual purpose (voltage/current) meter.

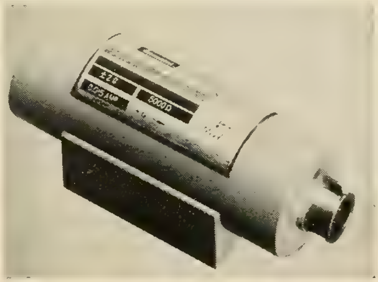
Circle No. 234 on Subscriber Service Card

Axial Accelerometer

An axial accelerometer designed for operation in a radiation environment has been developed by the Transducer Div. of Giannini Controls Corp.

The Model 24176 has a total range capability of 100 g's. Tests have shown it unaffected by neutron doses up to 3 x 10^{17} fast neutrons/cm^2. and gamma doses up to 2 x 10^{10} ergs/gm. (C) for periods up to 100 hrs.

Output is accurate within a typical dynamic error band of ±0.75%. Operational life is 1,000,000 cycles. Potentiometer resistance is available from 2,000 to 10,000 ohms, ±5%. Current rating is 10 milliamperes. Output linearity is 0.5%. Temperature environment is —65° to 300°F. The unit meets MIL-E-5272C specifications.



Circle No. 235 on Subscriber Service Card

Rate Controller

Sloan Instruments Corp. has developed the Model DRC rate controller for fully automatic vacuum evaporation.

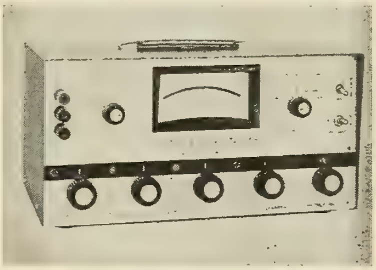
The device uses a quartz crystal oscillator as a microbalance and continuously differentiates thickness indication to achieve rate. In usual applications, the unit is the rate controlling portion of a closed servo loop control system and can be adapted to any source (filament, electron beam, RF, etc.). Yield rate control ranges from 1 to 40 amps/sec.

The system is supplied with the capability of later use as an alloy composition control system.

Circle No. 236 on Subscriber Service Card

Precision Voltmeter

Calibration Standards Corp. is marketing the Model DC-110B/BR Precision Voltmeter. The unit has an accuracy of ±0.02% ±5 microvolts over a range of 0 to 1,000v dc. Temperature stability is ±10 ppm/°C over an operating range of 10 to 40°C. Stability is 0.002% for a 10% line change.



The unit operates on 117v ac, 50 to 60 cps. Input is resistance-infinite from 0 to 10v dc, 2 megohms from 10v to 1 kv.

Circle No. 237 on Subscriber Service Card

Plug-in Filter

A plug-in integrating ac-to-ac mechanical filter, the Model T1160-001, has been developed by Kearfott Div., General Precision, Inc.

Operating at 400 cps, the filter's motor is rated at 57.5v fixed phase and 36v control phase. Vane pickoff excitation is 3.2v, 400 cps, and requires 3.5 ma. Torque constant is 344 dyne cm/volt; rotor inertia is 11.5 gm. cm.^{2} Viscous friction is 94,400 dyne cm. sec/rad.

Circle No. 238 on Subscriber Service Card

FM Transmitter

Radiation, Inc., has developed a FM telemetry transmitter for operation in the 216 to 260-mc range.

The Model 3116 is solid state and features separate power supply ground, case ground and modulation input return. Specifications include: frequency response—30 cps to 200 kc ±1 db; power output—4 watts minimum into 50 ohm lead; VSWR capability—6.1; voltage and power—25 ±4v dc 30 watts; ripple—5v peak-to-peak, 5 cps to 20 kc; radiated and conducted RFI—MIL-1-26600.

Circle No. 239 on Subscriber Service Card

CW Gas Laser

Maser Optics, Inc., is marketing the Model 720 CW Gas Laser, which provides a coherent source of power at 0.6 micron. The light beam is emitted from both ends of a 30-in. quartz discharge tube and is variable up to 3.5 milliwatts.

Substitution of Brewster angle mirrors makes possible operation of the unit at 1.5 and 3.39 micron. A microphone input can be used to amplitude modulate the laser beam.

Circle No. 240 on Subscriber Service Card

Soldering Probes

Contact, Inc., is marketing two models of its line of "Hotip" resistance soldering probes.

The P-30 is a double-contact probe with adjustable electrodes that permit variable tip spacing from 1/32 to 3/8 in. The tips measure 0.04 in. in diameter and are made of tungsten alloy.

The P-40 is a single-contact probe and can be equipped with 0.04 or 0.06-in diameter tips.

Circle No. 241 on Subscriber Service Card

Correction

The New Product of the Week for the Oct. 14 issue, an air-oil separator marketed by Seaton-Wilson Manufacturing Co., was incorrectly listed as weighing 30 lbs. The Model S-130 Separate-Aire measures 7⅞ in. long and 3½ in. in diameter and weighs 30 ounces.

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Circle No. 28 on Subscriber Service Card

Six-Way Pulse Generator

American Electronic Laboratories is marketing the Model 155 pulse generator, which provides operation in six modes without the use of external synchronization or control systems.

Modes available are: single pulse; single pairs of pulses; single trains of pulses; repetitive pulses; repetitive pairs of pulses; and repetitive trains of pulses.

Maximum power is 25 watts at 250v. Frequencies are calibrated to within 5%. Resetability accuracies are approximately 0.1%.

Circle No. 242 on Subscriber Service Card

Magnetometer

The Model V-4928 Rubidium Magnetometer is being marketed by Varian Associates for use in field geomagnetic research.

The system is comprised of a self oscillator, a readout and a solid-state potentiometer recorder.

Sensitivity is ±0.01 gamma. Dynamic range of readout covers 6,100 gammas, selectable at any region of the Earth's field. Output jacks allow frequency information to be transmitted by coaxial cable, radio, telephone lines or to tape and strip chart recorders.

Circle No. 243 on Subscriber Service Card

Frequency Counter

A frequency counter measuring 1¾ in. high and featuring in-line digital readout is available from Anadex Instruments, Inc.

The Model CF-203R handles frequencies in the 0 to 120-kc range. Time bases of 0.1 and 1 sec. are derived from 60-cps line frequency. Ten-second gate time is also available. Variable display time is from 0.2 to 6 sec. and hold. Sensitivity is 10 mv.

The unit is a four-decade model; five- and six-decade models are also available.

Circle No. 244 on Subscriber Service Card

Signal Transformers

Arnold Magnetics Corp. is marketing the TTJ Series of miniature toroidal signal transformers for use in low-level applications.

The units measure less than ½ in. high and 1 1/16 in. in diameter. They operate from inputs as low as 0.5 microvolts and cover frequencies from 200 cps to 10 kc. Operating temperatures range from −55° to 100°C. The transformers meet MIL-T-27A and MIL-E-5272C specifications.

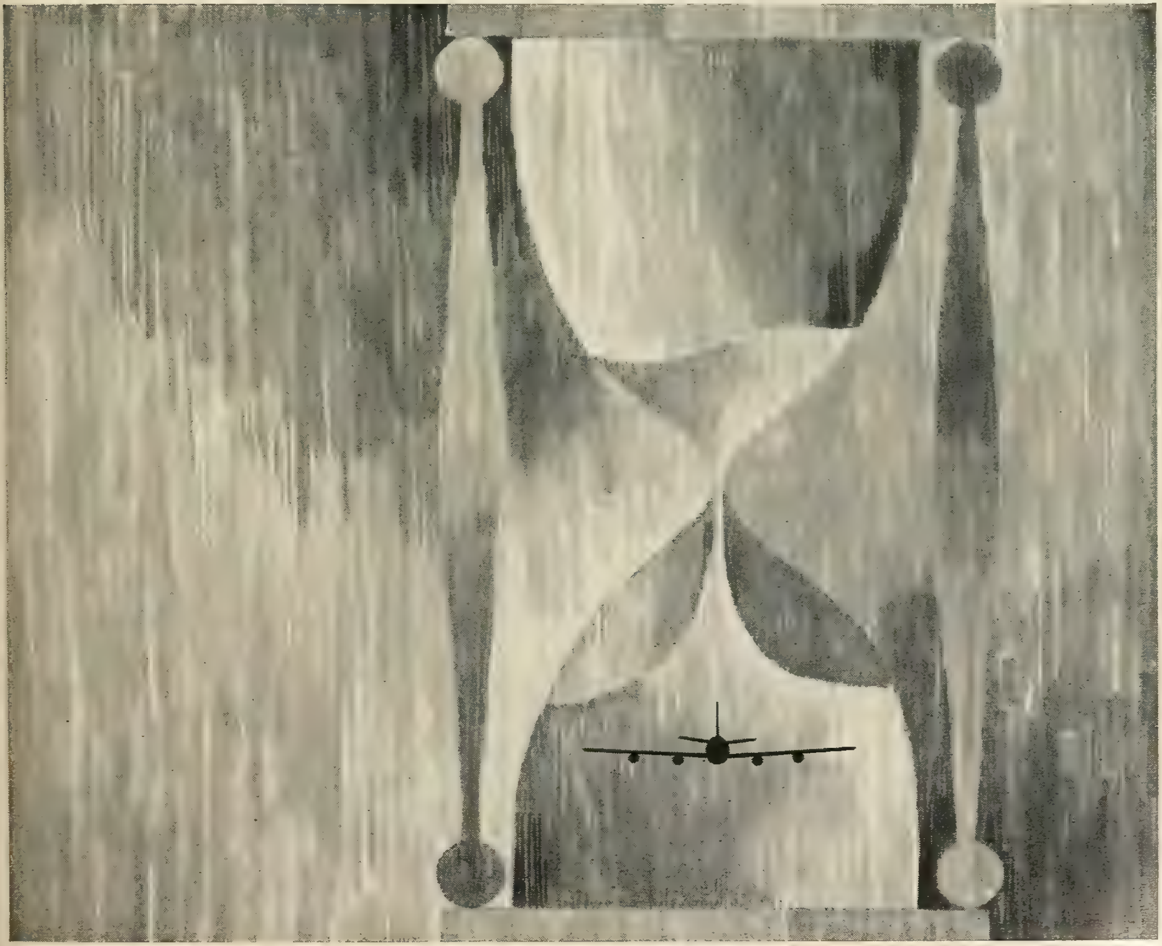
Terminal configurations are available for stacking, printed circuit boards, soldering or welding.

Circle No. 245 on Subscriber Service Card

AEROSPACE GERIATRICS

...AND WHAT DOUGLAS IS DOING ABOUT IT

In aircraft parts, as in men, excessive stress accelerates the aging process. And stress aging per hour varies for each aircraft. Yet the present way of determining servicing schedules is based primarily on hours flown. □ Now Douglas researchers have developed a device which, when installed on an aircraft, provides a more positive method of determining check-up times for aircraft parts. □ Called a "Service Meter," and weighing less than 1½ pounds, the Douglas unit computes the accelerations encountered by its aircraft in relation both to number and severity. It allows servicing to be performed on the basis of the true *work age* of parts, and will be an important aid to maintenance procedures that keep aircraft young. □ Research like the foregoing has helped build the Douglas reputation for producing the world's most reliable aircraft.



The "Service Meter" is one result of research programs in 23 broad technological areas now under way at Douglas. Some relate to present programs like SATURN S-IVB, ZEUS, DELTA, DC-9 and SKYHAWK. Others are oriented on great aerospace developments of the future.

DOUGLAS

names in the news

Dr. William B. Fallis: Joined Northrop Corp's Norair Div., Hawthorne, Calif., as member of technical management in charge of development activities in the field of hypersonic and lifting entry vehicles.

Don Fairchilds: Named director of public relations for the Singer Co., Metrics Div., Bridgeport, Conn.

William M. Ellis: Appointed marketing manager of the Research Div. of Electronics Communications, Inc., Timonium, Md.

Robert J. O'Brien: Joined Lockheed Propulsion Co., Redlands, Calif., as chief project engineer.

C. G. Chisholm: Appointed vice president and general manager of investment cast products for Union Carbide Corp.'s Stellite Div., New York City.

Bernard Kessler: Appointed vice president in charge of marketing for the Mica Corp., Culver City, Calif.

Thomas D. Webb: Promoted to vice president of Republic Industrial Corp., New York City.

Thomas D. Knowles: President of Goodyear Aerospace Corp., Akron, Ohio, has received an honorary doctorate of engineering from the University of Akron for "outstanding contributions to the field of engineering."

Dr. Walter P. Davidson: Appointed as a senior scientist at ITT Federal Laboratories, Nutley, N.J.

Charles J. O'Donnell: Appointed vice president of operations for the Kollsman Instrument Corp., Elmhurst, N.Y.

Lloyd L. Kelly: Appointed president of the Simulation and Control Group of General Precision, Inc., Binghamton, N.Y.

Donald S. Simpson: Joined Lockheed Propulsion Co. as manager of reliability engineering, Redlands, Calif.

Charles W. Stephens: named manager of the newly formed Optics Div. at Electro-Optical Systems, Inc., Pasadena, Calif. **Clifford I. Cummings** has joined the company as manager of the advanced systems development operations.

Dr. James E. Boyle: Appointed sales manager for laser products at Hughes Aircraft Co.'s electronic products division, Newport Beach, Calif.

Eugene J. Cattabiani: Named engineering manager of the atomic equipment division of Westinghouse Electric Corp., Cheswick, Pa. **F. A. Rosenthal** appointed project manager in charge of service and administration of government nuclear main coolant pump contracts.

Richard J. Heimer: Appointed chief optical designer at Fairchild Space and Defense Systems Div. of Fairchild Camera and Instrument Corp., Syosset, N.Y.

Robert J. Hanville: Appointed director of research and engineering for the Aerospace Div. of Walter Kidde & Co., Inc., Belleville, N.J.

Otto Riss: Appointed operations manager of Bendix Products Aerospace Div. of the Bendix Corp., South Bend, Ind.

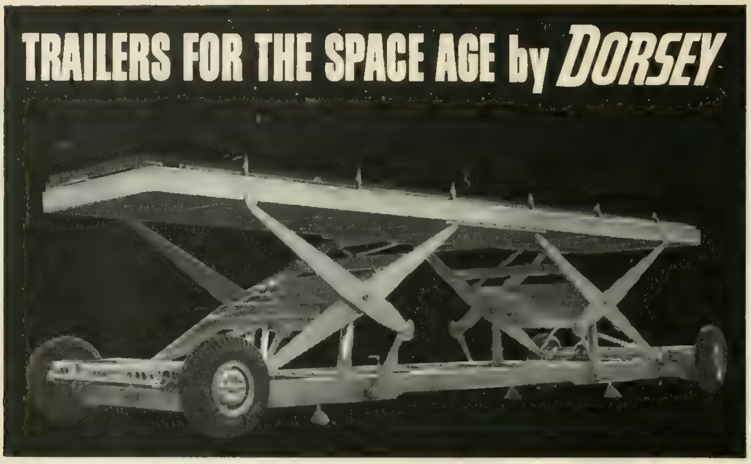
James J. Sullivan: Appointed director of manufacturing for Paradynamics, Inc., Huntington Station, N.Y.

Sidney Thurston: Joined Northrop Norair Div. of Northrop Corp., Hawthorne, Calif., as chief of advanced underwater systems.

Ormon E. (Sam) Bassett: Named manager of engineering for Avco Corp.'s Electronics Div., Cincinnati, Ohio.

William H. Coleman: Appointed West Coast regional sales manager for F & M Scientific Corp., Los Angeles.

TRAILERS FOR THE SPACE AGE by DORSEY



For projects requiring mobile equipment Dorsey's Special Products Division engineers help prime contractors and defense agencies hold time and cost to a minimum while insuring reliability. We build trailers to any desired stage of completion for electronic installations or to haul any type of critical cargo.
The experience of our engineers in special-feature design is especially valuable during initial-stage planning conferences. Can we help you? If urgency dictates, we can be at your desk within hours.

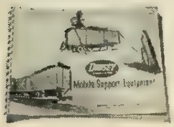
FOR AIRCRAFT CARGO LOADING

One of several elevator-platform trailers designed by Dorsey to raise and lower space vehicle parts or other cargo into and out of aircraft. Platform lifts 40,000 pounds from base height of 48" to air transport deck level, tilting the load as necessary. Dorsey contract, placed by NASA-Marshall Space Flight Center, including concept, design and production.

MOBILE U.H.F. GROUND STATION

AND COMMUNICATIONS

Built by Dorsey for Electronic Communications, Inc., this air-transportable van contains UHF multiplex equipment as well as calibration and repair facilities required for self-support.



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ENGINEERS & SCIENTISTS

ALL CHIEFS, NO INDIANS !

With tongue in cheek, this phrase might be applied to the scientists and engineers of Pan Am's Guided Missiles Range Division. Under the direction of the U.S. Air Force Missile Test Center, GMRD has, since 1953, been responsible for conceptual planning, specifications, and operation of the range instrumentation systems developed by industry for the Atlantic Missile Range. The decisions made by Pan Am's technical staff are vital ... directly affecting the success of each missile, space vehicle, and scientific probe launch operation at Cape Canaveral.

RANGE PLANNING analyzes projected program requirements up to 15 years ahead, predicts range support capability required and develops the advanced instrumentation system concepts.

SYSTEMS ENGINEERING utilizes these range plans to develop detailed specifications for all range instrumentation, data, and support systems. They then evaluate bids from industry to insure that capable industry sources will furnish such systems. This is only the beginning of their task—they follow and monitor the development of this equipment through installation and checkout.

RANGE OPERATIONS plans and evaluates range support for all launches, coordinates all range support activities, provides data and command/destruct for range safety, and manages the operation of down-range stations.

Individually and as team members, the men in these groups have become authorities in range technology. To add to the capability of the range, the following typical assignments are under way in Range Planning, Systems Engineering, and Range Operations:

CW and Pulse Radar: modify and improve sensitivity of Mistram, Glotrac, AN/FPQ-6, and AN/TPQ-18; develop velocity measuring system with an accuracy of 0.1 fps.

Telemetry: increase the operating range of antennas to cover frequencies up to 2300 mc; design a system which, upon command, will select the most important data from each station.

Optics: devise and install an orientation system for both CZR and cinetheodolites; improve ballistic cameras with respect to random errors, shutter speed, exposure time and time correlation.

Infrared: develop high resolution spectrometer for launch and re-entry coverage; implement a complete infrared measurement system for mid-range coverage.

Underwater Sound: introduce a nuclear battery power supply into the ship-tended acoustic relay (Star) and extend the range of this system.

Data Processing: add automated methods to enable more efficient handling of larger volumes of data with minimum degradation; convert processing of weather information to near realtime.

Meteorology: improve cloud height and growth indication instrumentation; develop a system to measure atmospheric electrical potential and cloud movement.

Instrumentation & Vehicle Control: automate the entire tracking network through a Range Instrumentation Control System; add space diversity to the Cape Canaveral command control system by adding a van-mounted 10 KW fast-reaction command control system.

Correlation: reduce time correlation uncertainty across the range to less than 100 microseconds; standardize the timing signal format on the AMR.

Radiometry: schedule and control all electromagnetic radiation within the missile test area with a Spectrum Surveillance System; automate, where possible, instrumentation for interference control, spectrum signature collection and quality analysis.

Data Handling: design equipment to permit very high density realtime data transmission over RF lines or submarine cable; increase the digital data equipment available at off-cable sites to provide more efficient on-site computer programming.

Range Safety: increase the electronic monitoring of launch hazard areas and of missile and spacecraft performance; install a second Range Acquisition Data Distribution & Control system to permit handling of dual missions; develop instruments to measure blast parameters and fireballs resulting from exploding missiles.

Ship and Aircraft Instrumentation: improve the instrumentation to meet more stringent telemetry, navigation, tracking, communications, and data handling requirements; phase into operation new and/or modified tracking ships and aircraft.

Capable engineers and scientists with applicable experience are invited to write in confidence to Manager, Range Development, Dept. 56K-4

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missiles and rocket

Advanced Research, Technology and Development

Issue Date
November 25
1963

Advertising Closes
November 11
1963

Projects Gemini and Apollo are well under way. The National Aeronautics and Space Administration is currently planning future projects like the orbiting space station, lunar base, manned Mars expedition, unmanned exploration of the Sun and the distant planets, and detailed investigation of Earth's environment

M/R's Third Annual National Aeronautics and Space Administration issue will be a 100-page report covering advanced research technology and development requirements for these programs

hird annual NASA issue

This issue will include:

. Advanced Research and Technology

Spacecraft Structures ☐ Propulsion ☐ Nuclear Systems ☐ Electronics ☐ Biotechnology and Environmental Systems

2. Funding Requirements and Procurement Policy

NASA's in-house apportionment of the Fiscal Year 1964 Budget ☐ Effects of Congressional cuts in the budget Report on Fiscal Year 1965 Budget ☐ Budget Projection through 1975

3. Advanced Development Programs

Manned Spaceflight ☐ Unmanned Interplanetary Spacecraft ☐ Scientific Satellites ☐ Commercial Application Satellites ☐ Launch Vehicles after Saturn ☐ International Programs

4. NASA Field Centers

New facilities and equipment required at each installation by the advanced spacecraft and launch vehicles.

5. Directory of Key NASA Officials

Name ☐ Job Title ☐ Room and Telephone Numbers

JULY 1963 SURVEY OF NASA OFFICIALS IN THE MANNED SPACE FLIGHT PROGRAM

Business Papers Read	Percent Mentioned
Missiles and Rockets	64.9%
Aviation Week & Space Technology	43.3%
Aerospace Management	19.6%

SOURCE: M/R Research Department

5,000 Bonus Circulation to NASA Officials

Total NASA Circulation 6,500.

43,170 Regular ABC paid circulation.

48,170 Total Effective Audience.

NASA will award many of the study and hardware development contracts for these projects by mid-1964. Advertise your products and capabilities in M/R's Third Annual NASA issue to reach your audience at this critical decision time.

Advertising Closes November 11

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—when and where—

OCTOBER

13th Annual Aerospace Fluid Power Conference, sponsored by Aerospace Div., Vickers Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 28-30.

Western States Section of the Combustion Institute Fall Meeting, University of Southern California, Los Angeles, Oct. 28-29.

National Electronics Conference, McCormick Place, Chicago, Oct. 28-30

IRE-PTGNS International Symposium on Plasma Phenomena and Measurement, El Cortez Hotel, San Diego, Calif., Oct. 29-Nov. 1.

IEEE 1963 Electron Devices Meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 1.

NOVEMBER

AIAA Vehicle Design and Propulsion Conference, Air Force Systems Command, Wright-Patterson Air Force Base, Dayton, Ohio, Nov. 4-6 (classified).

IEEE Northeast Electronics Research and Engineering Meeting (NEREM), Commonwealth Armory/Somerset Hotel, Boston, Nov. 4-6.

Society for Experimental Stress Analysis Annual Meeting and Exposition, Statler Hilton Hotel, Boston, Nov. 6-8.

ADME/AIAA/SAE/ASQC Joint Technical Conference, Disneyland Hotel, Anaheim, Calif., Nov. 7-8.

Magnetism and Magnetic Materials Conference, sponsored by AIEE, IRE and AIP, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., Nov. 11-15.

Seventh Annual NMR-EPR Workshop, sponsored by Varian Associates, Palo Alto, Calif., Nov. 11-15.

Fall Joint Computer Conference, sponsored by IRE, AIEE, Association for Computing Machinery and American Federation of Information Processing Societies, Las Vegas Convention Center, Las Vegas, Nev., Nov. 12-14.

Seminar on Automatic Checkout Equipment and Techniques, sponsored by NASA's George C. Marshall Space Flight Center and Satellite Memorial Institute, Columbus, Ohio, Nov. 13-14.

Sixth National Symposium, Society of Aerospace Material and Process Engineers, Olympic Hotel, Seattle, Nov. 18-20.

Engineering in Medicine and Biology Conference, sponsored by AIEE, IRE and ISA, Lord Baltimore Hotel, Baltimore, Nov. 18-20.

AIAA Annual Meeting and Space Flight Exposition, National Guard Armory, Washington, D.C., Nov. 18-24.

Conference on Stratosphere-Metosphere Structure, sponsored by Texas Western College, American Meteorological Society and AIAA, El Paso, Nov. 19-21.

Pipe being welded during installation in liquid hydrogen bubble chamber at Brookhaven National Laboratory.

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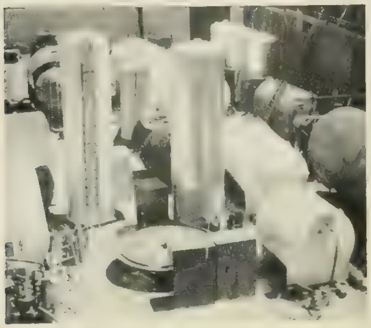

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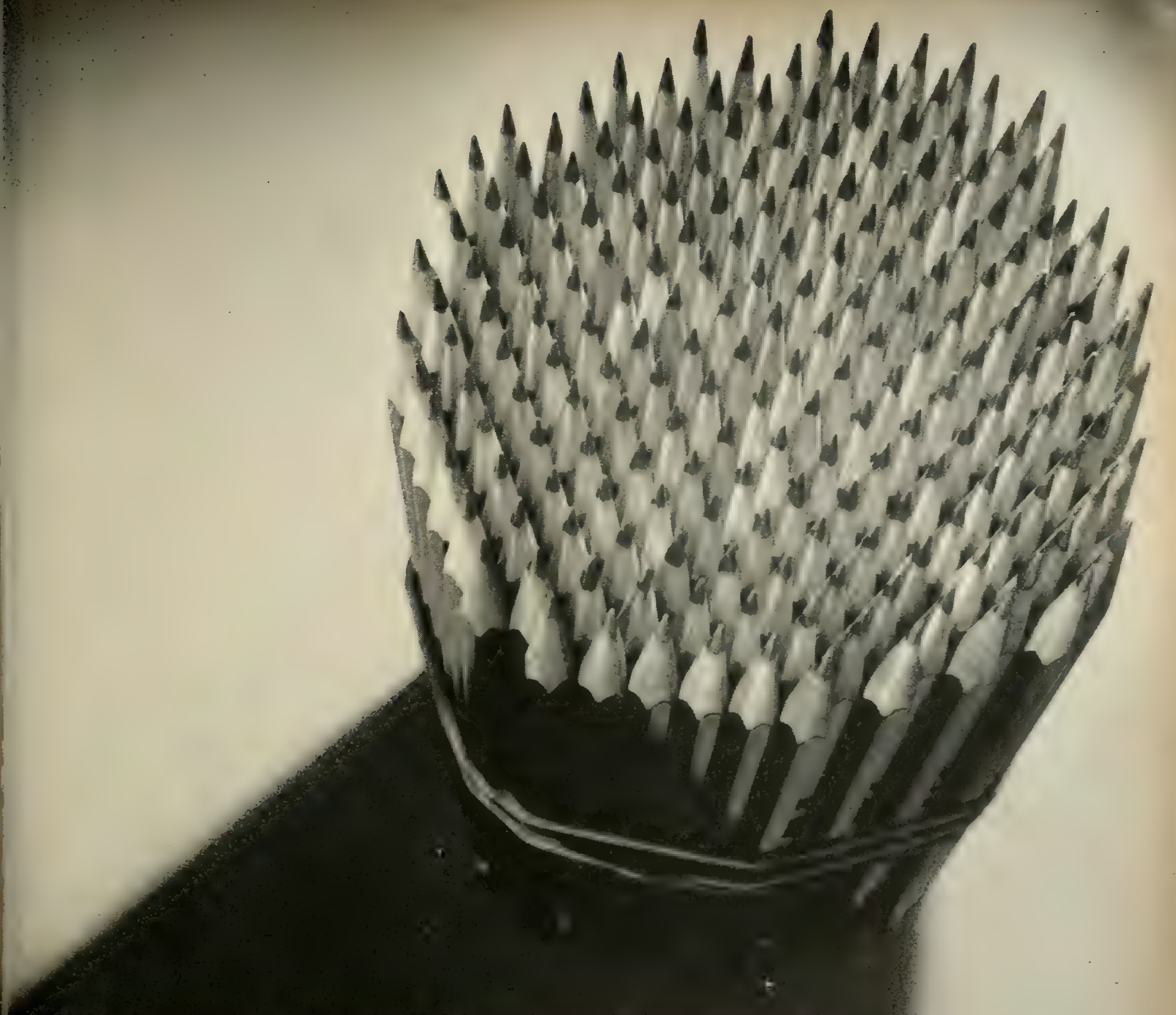

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Profile of an Industry

THE MISSILE/SPACE INDUSTRY is nearing maturity as the nation's No. 1 industry. Government figures show it soon will pass the automotive industry as the largest U.S. industrial employer. Coincidentally, the industry is under the heaviest fire of its history from those who charge it is a profligate spender of national resources.

Beginning on page 22 of this issue, we present the first of a three-part series by Senior Editor William Beller which will detail the characteristics of this new industrial giant. We consider this to be one of the most important subjects covered in these pages in some time.

All too often we concern ourselves with the trees and forget the forest. Not only has the industry grown explosively, it has matured and undergone a change of character in these years. It is important that those of us in the industry understand exactly the nature of our business and the strength and responsibilities of our industry—particularly at this critical time when its goals are being challenged at the highest national levels.

The significant industry trends must be recognized not only by those within the industry itself but also by its most important government customers—the Dept. of Defense, National Aeronautics and Space Administration, Weather Bureau and Atomic Energy Commission—as well as the Administration and the legislators who play such an important role in budgeting and procurement.

Perhaps the most challenging task is to recognize the vast difference in the industrial scale exemplified by the nation's two largest industries. The automotive industry essentially is a production industry and the government is not its major customer. These two facts imply a different set of standards on which its performance, profit margin, labor requirements, and rules and regulations are based.

The missile/space industry is an entirely different breed of cat. Long production runs are the exception, not the rule. It is heavily engaged in research and development, with a corresponding need for more highly skilled, and therefore more highly paid, workers. Almost all of its business is done with one customer—the government.

These essential differences must be recognized in a variety of areas. On the one hand, it must be realized that as the nation's largest industry, the missile/space industry is located in the vitals of the nation's economic well-being, a fact of which the government must remain constantly aware in making decisions on major spending programs. Cancellations can disrupt whole communities. Equally, initiation of large-scale programs can affect entire towns and cities, calling for advance planning on social programs such as schools, sewers, highways and housing.

On the other hand, government responsibility and control cannot be carried too far or the free enterprise system, so vital to successful completion of the projects in which the industry is engaged, will be crippled. The proper balance is extremely difficult to achieve and the need for it must be kept constantly in mind.

In the area of procurement, both industry and its government customer must recognize the new relationship required by the nature of this industry. The government is buying research and development skill; no longer do the same rules apply in the areas of profit margins, contract procedures, customer participation in project management and subcontracting.

Both the Aerospace Industries Assn., which paid for the Stanford Research Institute study discussed in Mr. Beller's article, and the Dept. of Defense are in the early stages of a common effort to come to new understandings. NASA is a participant in this. It is an undertaking which should be carefully nurtured, and Defense Secretary McNamara is to be complimented for his recognition of this fact. It is one of the Secretary's most important tasks, and one in which NASA's Administrator James E. Webb shares an equal concern.

THESE ARE NOT MATTERS which achieve headlines in the daily press, but their outcome can greatly affect the success of the vast projects in which the industry is engaged.

The industry, in full recognition of its nature, must also stand ready to listen to its responsible critics and to effectively counter the irresponsible ones.

The testimony of Dr. Edward Teller before Congress earlier this month, for example, was an able critique of some of our weaknesses, particularly in regard to applied research.

By contrast, the applauding last week by a forum of scientists of Dr. Linus Pauling's muddle-headed attack on the U.S. lunar program verged on the nauseating. It was an attack based on inane and juvenile reasoning. Why does the ability to understand what goes on inside an atom make a scientist feel he is an expert on everything else in the world? The industry must be as prepared to meet such attacks as it is to take to heart responsible criticism.

We are the nation's youngest and soon-to-be-largest industry. We are not making pipe, we are on our way to the stars. If we fail to understand in detail the nature of our industry and its undertakings, if we fail to understand our responsibilities and challenges, and if we fail to meet them, we will have failed not only ourselves but our nation.

Mr. Beller's series should be read with that thought in mind.

William J. Coughlin

USS ANDREW JACKSON, MARE ISLAND...CONCLUDED FIRST WEAPON SYSTEM SEA TRIALS ON FRIDAY. PUT INTO PORT WITH TEST DATA ON 32 REELS OF DIGITAL MAGNETIC TAPE. EACH REEL HAD 28 MILLION "WORDS" DESCRIBING THE SYSTEM PERFORMANCE. BEHIND THE SCENES, THREE VITRO LABORATORIES PROJECT SECTIONS JOINED THE VITRO COMPUTER GROUP TO PROCESS AND EVALUATE THESE 896 MILLION "WORD" TEST DATA. THEIR VITAL REPORT WAS ISSUED THE FOLLOWING MONDAY. NAVY REACTION, "HERCULEAN EFFORT."

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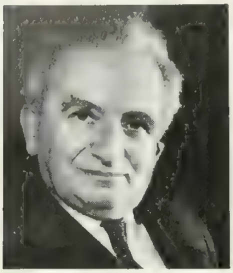

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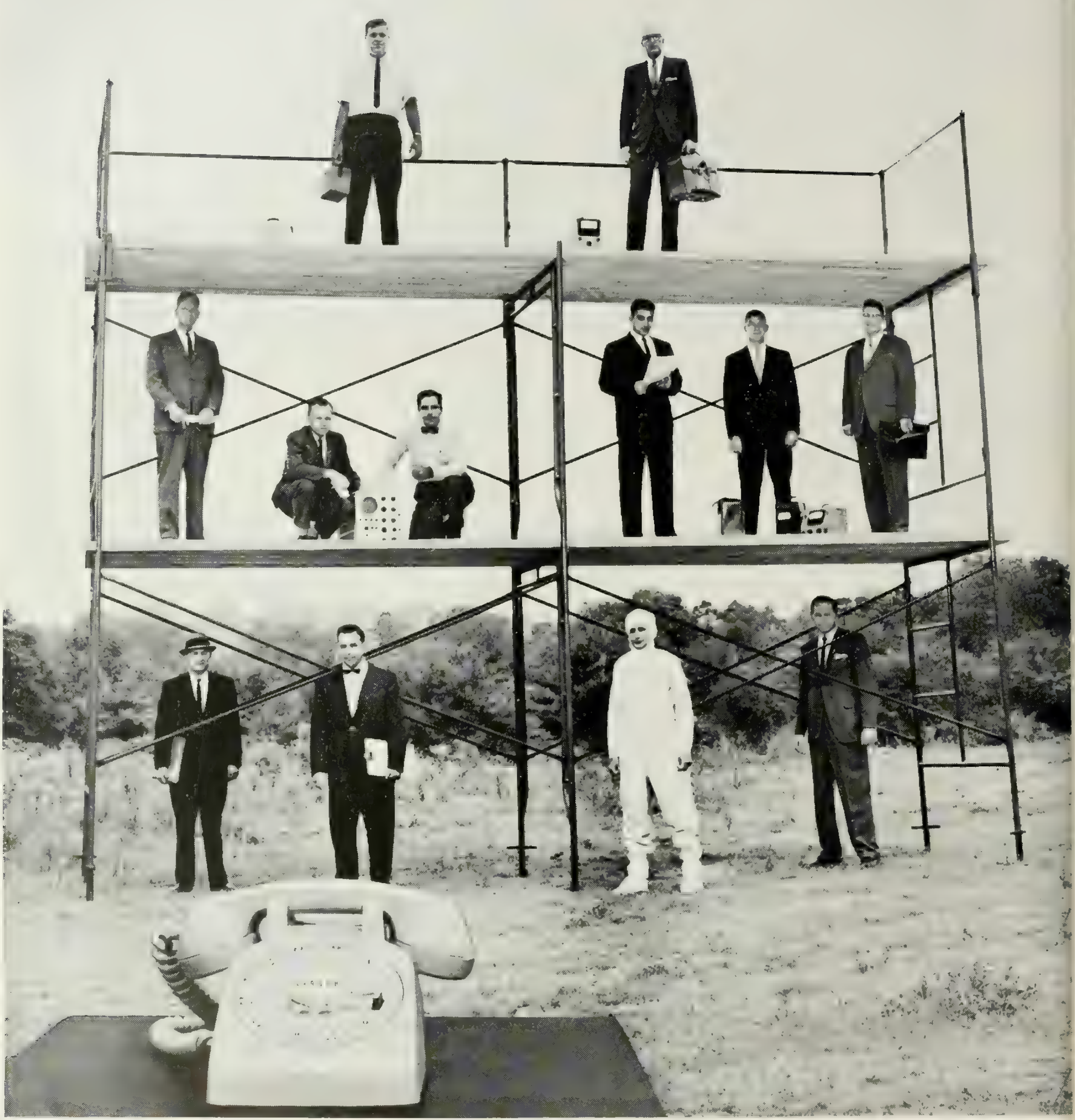

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THE COVER

Polaris A-3 was fired from U.S.S. Andrew Jackson 2,000 miles down the Atlantic Missile Range Oct. 26 in first shot of advanced Polaris from submerged submarine. Navy later disclosed it is pressing to get approval of R&D funds for proposed B-3 bigger-payload successor to Polaris. See page 18.

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47,750 copies this issue

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letters

State of the Union

To the Editor:

Since last July I have had in my "things to do" file a copy of your July 22 "State of the Union" editorial.

The only purpose of this letter is to tell you personally that I think it is one of the best editorials on the "State of the Union" which has ever been published. You have earned my undying gratitude for your courage and your ability to call a spade a spade.

B. G. MacNabb
General Dynamics/Astronautics
San Diego, Calif.

Simplicity and Planning

To the Editor:

Now that the dust has settled following the recent *Mercury* and *Vostok* flights, may I be permitted to make a few observations for your readers' consideration.

You were good enough to publish a letter of mine in M/R, April 10, 1961, in which I suggested a simplification of booster thought and planning. I was surprised that such remarks prompted no reaction either in your columns or in private communications.

Much discussion has occurred concerning the *Vostok* booster, and I would suggest that it is purely a development of the *T-3A* ICBM. The Model B with a first stage of four R14A engines would have a thrust of 1,072,000 lbs. (not 820,000 lbs.—M/R, July 29, p. 148), and a second-stage thrust of 536,000 lbs. Such a booster would surely be capable of orbiting 14-15,000 lbs. at 100-200 n. mi. Also, the use of one engine, one fuel system, and one type of airframe for probably 10-12 years would result in the reliability that the USSR has been able to achieve. If the number of first-stage engines be increased and/or LOX/H_2 is used in the second stage, then the payload could be upped to 20-25,000 lbs. in orbit. With the recently demonstrated double launch technique and rendezvous this could be 40-50,000 lbs.—a fair-sized space platform.

When one surveys the U.S. boosters one sees a large selection of engines and airframes. A comparison of *Saturn 1* and *1B* serves as an example. *Saturn 1B* requires the development of a new engine and a new second stage, both expensive, simply to increase the payload by 8,500 lbs. in the 20-25,000-lb. range. In addition, *Titan III* is planned to place 15-20,000 lbs. in orbit. Another example is seen in the comparison of *Atlas-Agena, Atlas-Centaur,* and *Titan II* boosters.

Of all launches, only *Atlas* and *Thor* have shown any reliability, and then only in the past 18 months, and these because they use the same engine and have been developed over several years. Perhaps the fact that *Saturn I* uses the same engines may account, in no small way, for the four straight successes of this first stage.

From this preamble two points come to the fore.

Firstly, simplicity in numbers of engines and systems used will result in reliability and reductions in costs.

Secondly, the long-term planning of payload weights and booster capabilities. An example of this may be the marginal performance of *Saturn V* for an *Apollo* mission. Compare also the marginal performance of *Mercury-Atlas* with the *Vostok* weights of 10,500 lbs. with a booster capable of orbiting 14-15,000 lbs. This allows room for additional weight without reducing performance range to below desired and/or safety levels.

C. P. Wilson
London, England

Why the Moon

To the Editor:

Re: Going to the Moon Likened to Climbing Mt. Everest—Because It's There.

I would think that after Mt. Everest has been climbed a number of times, and that after all the methods of preparation, materials, and techniques have been proven, climbing any lesser mountain would no longer be much of a challenge. When men climb lesser mountains in preparation for that far-off dream of someday climbing Mt. Everest, their ambition seems more logical to me. The only reason I could see for climbing smaller mountains now is to prepare the novice mountain climber to be able to conquer the big ones someday. It now becomes a matter of personal ambition, since it is doubtful that another team will discover anything new either about techniques of climbing or of what exists at the top of Mt. Everest. In a strong measure, some personal ambition without regard to scientific advancement must certainly be part of the psychological makeup of an astronaut.

The main compensation, then, of going to the Moon is not "because *it's* there"—but because the *planets* are there! The main purpose of going to the Moon is because the stars are there, the galaxies exist, and an expanding universe awaits its master!

We do not conquer Mt. Everest to prepare us for conquering lesser mountains. To conquer Kilimanjaro was a worthy attempt because it prepared us to conquer Mt. Everest. Therefore, to conquer the Moon, a lifeless ball of rock whose composition could possibly be detected without man going into space, is particularly worthy in that it leads us further on the road to finding out what is on the planets, where else man exists, what the stars are made of, how the stars envolve, and on and on until we can solve the problem of how man can understand and control *all* natural processes.

Howard M. Roseman
General Electric Co.
Washington, D.C.

STL NEW PROPULSION OPPORTUNITIES
In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

Requirements include a degree in engineering or science with appropriate experience.

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Experience in the design, development or testing of liquid propellant propulsion systems, rocket engines, feed system components, thrust chambers, injectors and thrust vector controls.

ROCKET ENGINE TEST STAND INSTRUMENTATION AND CONTROLS
Experience in the design, installation, operation or maintenance of liquid rocket engine test stand data acquisition (analog and digital) and control systems.

RESEARCH AND ANALYSIS
Experience in heat transfer, hydraulics, gas dynamics, combustion, ablative materials, and data processing and analysis.

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☐ RELIABILITY AND QA

Engineering Specialist—BS plus 10 years experience. Coordinate reliability technical effort with technical divisions. Represent Parts Reliability Staff Office at appropriate Design Reviews including assistance in preparation of Review materials. Perform surveillance and monitoring function on Lab Piece Part Reliability activities. Perform liaison, training and consultation to all parts reliability efforts at JPL.

Staff Engineer—BS in Engineering or Physics mandatory. Basic grounding in engineering design and test at the working and supervisory level. Quality Control engineering and supervisory experience in weapon systems or major electronic assemblies.

☐ SYSTEMS

Senior Research Engineer—MS with 3 years experience. Analytical studies of complex lunar spacecraft missions from point of view of relating the celestial mechanics problems to the expected "value" obtained by alternate actions. Development of analytical techniques to handle such problems.

Research Engineer—MS with at least 2 years in research or engineering problems related to space flight. Define and analyze mathematical models of guidance for lunar spacecraft with particular emphasis on control theory and statistical estimation. Study of the interacting problems of orbit determination and trajectory correction to develop optimal techniques for specific objectives.

Senior Engineer—BS plus 5 years experience required. Will have the system responsibility of integrating the various scientific experiments (e. g. radiometer, plasma detectors, magnetometer, etc.) with the remaining subsystems on the spacecraft. Specific duties include: 1) Accept inputs and schedule necessary test time for his area of responsibility. 2) Write procedures covering the interfaces between his area and the remainder of the spacecraft. 3) Evaluate and write related reports from test data.

Research Engineer—MS plus 2 years experience. To develop mathematical models of complex man-machine system operations leading to computer simulation and empirical evaluation of system performance.

☐ SPACE SCIENCES

Senior Research Specialist—BS with MS desirable. Advanced courses in geometrical and physical optics, with 15 or more years experience. Responsible for detailed technical monitoring and progress on all the optical instrumentation elements related to the specific space program connected with the television spacecraft systems. To review in technical detail, the approach and performance of the vertical contractors and subcontractors to assure conformance with specifications and mission success.

Senior Scientist—PhD with emphasis in space-oriented subjects. Three or more years experience. Must have conceived, designed and carried out some original research in experimental physics.

Design Engineer—BS plus 5 years minimum design experience in instrument or small mechanism design or equivalent. Design of physical science experiments and instruments and breadboard models of flight scientific instruments.

☐ TELECOMMUNICATIONS

Senior Research Engineer—MS plus 5 years experience in RF systems and/or circuitry. Development work in RF subsystems. Work concerned with wide band RF frequency multipliers and with frequency synthesizers characterized by low phase jitter and high spectral purity.

Operations Project Engineer—BS plus 8 to 10 years experience. Experience in operation of tracking station and networks, also with the technical systems and subsystems in tracking stations. Involves planning and scheduling of tracking operations. Will act as liaison between the DSIF and other JPL organizations in establishing the equipment and procedures to meet requirements.

Senior Research Engineer—BS with MS desirable. Two to 4 years experience in design and analysis of microwave antennas and microwave components desirable. General familiarity with antenna measurement techniques. Design and analysis of feed systems and wave guide components for large ground antennas.

Research Engineer—MS plus 2 years experience in communication, telemetry or radar system design and analysis. Analyze and solve telecommunication system problems in direct support of design, development and use of spacecraft telecommunications systems.

Senior Development Engineer—BSEE necessary and MSEE preferred. Five to 10 years experience in microwave system development. Radio communications techniques; UHF and microwave systems development of receiving and transmitting ground equipment.

☐ GUIDANCE AND CONTROL

Research Engineer—BSEE or MSEE with background in probability and statistics desirable. Develop advanced, reliable automatic test equipment for use with space vehicle guidance and control systems in laboratory, system and field checkout operations. Includes determination of functional requirements, design of circuits and logic, breadboarding, supervise prototype fabrication and participation as flight/GSE cognizant engineer in testing operations at JPL and Cape Canaveral.

☐ ENGINEERING MECHANICS

Senior Engineers (Structures)—Requiring active participation in the structural design and development of spacecraft; working familiarity with problems ranging from "nuts and bolts" to matrix methods of structural analysis; sufficient interest in academic pursuits to promote state-of-art advancements. Requires MS with 7-10 years experience in project support of aircraft, missile or spacecraft programs.

Structural Dynamics Engineers—Responsible for initiation and performance of model vibration analysis, dynamic loads analysis and testing in support of spacecraft design and development. Must have working familiarity with launch vehicle dynamics, including aeroservoclastic coupling. MS with 7-10 years experience applicable to position requirements.

☐ ENVIRONMENTAL

Senior Research Engineer—BS with some course work in heat transfer. MS desirable with 5-10 years direct experience in testing. Environmental testing experience is preferred but other types of testing are acceptable such as wind tunnel or flight testing.

Senior Research Engineer—BS with MS preferred. Five to 10 years direct experience in hardware testing. Environmental testing experience preferred particularly in the acoustic, vibration and shock areas. Other types of testing such as flight testing, flutter and vibration may be considered.

Senior Design Engineer—BS required, MS preferred. Six to 8 years minimum experience of a broad nature, analysis and project areas. Prefer some experience outside aircraft industry. Perform technical and economic feasibility studies of advanced facilities in vacuum technology, cryogenics, electricity, magnetism, optical and thermal systems, structures, aerothermodynamics, etc.

☐ PROPULSION

Advanced Propulsion Engineers—For analysis, evaluation and development of power conditioning systems for advanced electrically propelled spacecraft. BS or MS in EE or Physics with 4 years experience in aircraft or missile electric power generation and distribution system design and test. Some servomechanism experience also desirable.

Send complete resume to:

jpl

JET PROPULSION LABORATORY
4808 Oak Grove Drive, Pasadena, California
Attention: Personnel Department 11

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Jet Propulsion Laboratory is operated by the California Institute of Technology for the National Aeronautics and Space Administration.

The Countdown

WASHINGTON

Chrysler Halts Work on SA-11, SA-12

NASA's switch to the *Saturn IB* for manned *Apollo* flights has temporarily halted Chrysler Corp.'s work on the *SA-11* and *SA-12* vehicles. These will be converted to the *S-IB* configuration. NASA officials report they expect no increase in the number of *S-IB's* built because of the switch.

Navy To Flight-Test New ASW System

Prototype of a revolutionary airborne antisubmarine system nicknamed A-News is being assembled at Naval Air Development Center, Johnsville, Pa. System, to be flight tested at San Diego, is said to include the most advanced sensing, display and computer equipment ever used to track hostile submarines.

A Forecast on Project Forecast

Insiders say the Project Forecast study of Air Force requirements, just reviewed by Secretary of Defense Robert McNamara and sent back for more work, puts heavy emphasis on the need for a manned space station. Says one observer: "I think the Air Force has done a lot more homework and now is better able to justify it."

No Explanation for Atlas F Failure

Air Force at Cape Canaveral has yet to give an explanation for the sudden failure of an *Atlas F* which got off to a good start on a launch Oct. 28, then apparently flopped over in midair. However, one Canaveral source flatly denied a report that the trouble was due to loss of control of an engine exhaust nozzle.

NASA Negotiates for More Delta Vehicles

NASA is negotiating with Douglas Aircraft for additional *Delta* launch vehicles. Estimated cost: $5 million. Program calls for a launch capability of one per month in 1964.

MSC to Seek Training Facility Bids

Manned Spacecraft Center will ask for bids on Nov. 21 for construction of its Missions Simulation and Training Facility. Bids will be opened Dec. 20. Equipment—including simulators, trainers and computers—will be procured in a separate action.

INDUSTRY

Some Industry Officials Favor Stretchout

Most industry officials deplore the possibility of a stretchout in Project *Apollo*. Some, however, believe it would benefit the program. One says a stretchout would help suppliers because it would ease the drain on top talent. Another says it would upgrade the quality of *Apollo*. As an example, he cites the many gray areas where promising developments such as integrated circuits cannot be used because NASA insists on items which have been totally proven.

Sight Provides Shillelagh Accuracy

A stabilized sight which permits the *Shillelagh* antitank missile to be fired from a helicopter is said to maintain the weapon's high accuracy despite aircraft motion. The sight was developed by Philco's Aeronutronic Division, *Shillelagh* prime contractor. The sight is said to achieve an order-of-magnitude increase in accuracy over previously developed Army fire control equipment.

Airborne PRESS System for PMR

Douglas Aircraft is installing a PRESS airborne instrumentation system in an NRA-3B aircraft to be used in DOD's ballistic missile measurement program on Pacific Missile Range. System includes five infrared/visible sensors clustered on a modified B-50 turret. Instrumentation platform control and stabilization system is made by General Precison Inc. RCA fabricates data link equipment to supply pointing information to the aircraft before re-entry.

Ice Structures on Moon?

A major aerospace firm has developed an inexpensive water explosive forming technique using ice dies. Method looks promising for areas—such as a lunar base—where tolerances aren't critical and industrial tools are lacking. Given a conical shape, for instance, a master die need be made of only one section; required number of sections are then made from the die and welded together with water.

DOD, NASA Press Explosive Hazards Study

New program to evaluate propellant explosive hazards for both NASA and DOD is in progress at the Air Force Rocket Propulsion Laboratory, Edwards AFB, Calif. Testing will begin soon under direction of a newly formed Hazards Analysis Branch funded by both agencies, and is expected to continue for two years. Investigation, a secondary effort until now, is being accelerated because of the threat inherent in increasingly larger boosters.

Global Wins Atoll Logistics Job

Navy is negotiating a contract with Global Associates, Inc., Oakland, Calif., for services and materials necessary in the logistics support of the Kwajalein and Eniwetok atoll installations of the Pacific Missile Range. Other bidders were Pan American World Airways, Cocoa Beach, Fla.; Holmes & Narver, Los Angeles; Pomeroy Hawaii Dredging of Honolulu; and Transport Company of Texas.

INTERNATIONAL

French Space Agency Sets Plans

CNES, the French national space organization which is the counterpart of NASA, will carry out the main body of its space research in a center at Toulouse which is expected to be operational by 1967. Other centers will include: Bretigny, a small center for scientific and technical work; Marseilles, location for an astrophysics team to work with Mediterranean observatories and Aire-sur-Adour, balloon launching center. CNES headquarters: Paris.

X-15 Speed to be Boosted

X-15 rocket plane No. 2 will be modified to achieve a higher speed capability so that it can be used early next year in an extended hypersonic flight research program.

Damaged last November in a landing accident, No. 2 may also be used later to test ramjets slung under the fuselage.

The Air Force has signed a letter contract with North American Aviation, Inc., builder of all three *X-15's*, to do the work. The contract, worth about $5 million, is to be completed by March 1, 1964.

The modified aircraft, one of three operated by NASA and the Air Force at Edwards AFB, Calif., will carry an additional 13,500 lbs. of propellants to increase engine running time to 145 seconds at full throttle. Present maximum is 86 seconds at 100% thrust. The added burning time theoretically will raise the speed by some 1,300 mph, but because of structural and aerodynamic heating and other considerations, the actual increase will be somewhat lower.

Although the modifications will increase the speed, the *X-15* flights will be restricted to present altitude capability. The ceiling is limited by the problem of re-entering the Earth's atmosphere from nearby space because of high dynamic pressure, high g-forces in recovery and heating limitations on the airplane structure.

Modifications to the damaged rocket plane will involve work on its landing gear, wings, fuselage and canopy.

UAC Gets 'Lunarcycle' Pact

United Aircraft's Hamilton Standard Div. has received a $68,717 fixed-price R&D contract for studying and formulating design criteria for a one-man rocket-powered propulsion system for use in space or lunar environments.

The study, to be completed by April 30, 1964, is expected to produce a preliminary design for a system that will allow an astronaut on the Moon to rise and descend vertically, travel in any controlled direction, hover, rotate, perform rescue missions, glide over smooth terrain, and scale steep slopes—all under manual control.

The unit is also to include an automatic control for stabilizing the astronaut during flight. Design will center around a Manned Spaceflight Center requirement that the system be an extension of existing equipment and techniques.

Shots of the Week

A 13-shot series of overland *Pershing* firings was concluded Oct. 28 with one success and one cancellation. Five shots were from Black Mesa, Utah; two from Ft. Bliss, Tex.; and the last six from Ft. Wingate, N.M. All impacted within the White Sands Missile Range, N.M. as intended. The series was conducted by the 2nd Missile Battalion, 44th Artillery, from Ft. Sill, Okla. According to the Army, primary objectives of the series were met.

Other shots of the week:

- The Air Force launched a secret satellite aboard a *Thor-Agena*

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vehicle Oct. 29 from Vandenberg AFB, Calif.

- An Air Force *Atlas F* failed spectacularly Oct. 28 after an apparently successful launch from Cape Canaveral. The 82-ft.-long ICBM began tumbling end-over-end shortly after second-stage separation and destroyed itself.
- The Navy successfully fired the *Polaris A3* for the first time from a submerged submarine, the U.S.S. Andrew Jackson, Oct. 26 (see p. 18).
- The Air Force launched an *Atlas-Agena* bearing an unidentified satellite from Point Arguello, Calif., Oct. 25.
- The next to last *Pershing* tactical missile fired in the Ft. Wingate, N.M., series exploded shortly after launch Oct. 23.

NASA Seeks LH_2 Supplier

NASA is negotiating with the Linde Co. division of Union Carbide Corp., and Air Products and Chemicals, Inc., to select a contractor to supply liquid hydrogen to the Mississippi Test Operation and the Marshall Space Flight Center.

Under terms of the contract, the supplier must have the capability of producing up to approximately 115 million lbs. of liquid hydrogen from April, 1965, through December, 1970. However, the amount to be purchased during this period will depend on actual requirements of the testing program.

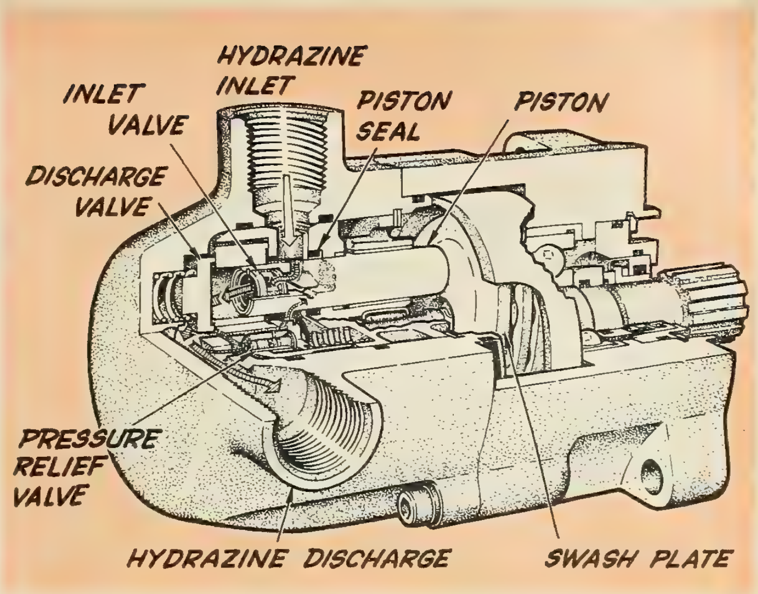
The contract will be renewable on an annual basis at the option of the government and, if options are exercised through December, 1970, could result in a total expenditure in excess of $19 million.

Primary use of the liquid hydrogen will be for static testing the second stage of the *Saturn V launch* vehicles at the Mississippi Test Operation. It will also be used for testing operations at Marshall.

NASA to Get TAT

NASA is adopting the Air Force-developed *Thrust Augmented Thor* as a booster for the *Agena* and *Delta* vehicles being used in its National Launch Vehicle program.

The *Thrust Augumented Thor-Delta* is expected to provide a 20-30% increase over present *Delta* performance capabilities. The new configuration is expected to make its first NASA flight sometime next year. The *Biosatellite* and *Orbiting Solar Observatory* programs are expected to be among the first to use it.



PROBLEM: To Develop a Pump to Handle a Low Lubricity, Corrosive, Monopropellant for Space Application

SOLUTION: **SUNDSTRAND'S POSITIVE DISPLACEMENT HYDRAZINE PUMP**

In order to utilize lighter, low pressure fuel tankage for a storable space power system, Sundstrand engineers faced the problem of developing a fuel boost pump which would handle hydrazine.

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Here's where Sundstrand's long experience in the design of positive displacement pumps and motors paid off. More than 75 hours of operation at 6000 rpm as part of a space power system has proven that the Sundstrand-developed pump performs easily within these specifications. Volumetric efficiency of more than 90% has been demonstrated.

The poor lubricating qualities of hydrazine were side-stepped by eliminating sliding valves, minimizing side loading between piston and cylinder, and exercising extreme care in selection of materials. Lubrication of other moving parts was accomplished by isolating them from the hydrazine.

This basic pump design for low lubricity fluids has many applications in other hand-to-handle fluids. Perhaps you have an application for such a pump, or perhaps you have a fluid supply system problem that Sundstrand engineers can help you solve. For more information on this pump or a description of our varied experience and facilities, write to: Manager, Applications Engineering.

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Allis-Chalmers research for NASA's *Marshall Space Flight Center* and the *Air Force* has produced a fundamental breakthrough in the art of fuel cell moisture control and removal in the *vapor phase* by a *static method.* A bonus is the great simplification for thermal control at *low temperature.*

The result is a hydrogen-oxygen fuel cell system that is much lighter than any other known system. Pictured on the right is the 1-kw unit weighing just 50 pounds and measuring 20″ x 10″ in diameter. And, as the repeated demonstrations have proved, it is operational *right now!*

A further indication of confidence is the fact that the *Air Force Aeronautical Systems Division* has selected Allis-Chalmers to build a 50 watt hydrogen-oxygen system for the first orbital fuel cell flight. This system has successfully passed shock, vibration, acceleration, zero gravity and full power testing.

What are the other significant facts about Allis-Chalmers fuel cell capability?

1. We are studying mobile energy depot systems for the *AEC* and the *Army. Significance: These systems would use nuclear reactors to generate fuel. Fuel cells would power the vehicles, alleviating logistical problems of supplying fuel to a modern army on the move.*

2. Under development now — a fuel cell and the integration of a 5-kw hydrocarbon-reforming fuel cell system for the *Army's Engineer Research and Development Laboratories. Significance: This system will "crack" inexpensive hydrocarbon fuels to obtain hydrogen for the first major air-breathing fuel cell.*

3. Our 7-kw hydrazine-oxygen fuel cell powers an experimental, 2000 lb fork lift truck. Our 3-kw hydrazine-oxygen fuel cell powers an experimental golf cart. *Significance: Multiple kw fuel cell systems have been applied to vehicles like the experimental golf cart that have been demonstrated to thousands of people from coast to coast.*

4. We've announced discovery of nickel boride as the material to replace platinum for the anode catalyst. *Significance: This is the first inexpensive and efficient anode catalyst for fuel cells using hydrogen-oxygen or hydrazine-oxygen.*

Now, may we discuss your aerospace or defense fuel cell application?

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ALLIS-CHALMERS

for space power

By Khrushchev reaction . . .

FY '65 Apollo Funds Threatened

Russian leader's remarks acknowledging lunar program are misunderstood; no effect likely on FY '64 appropriation

PREMIER NIKITA KHRUSHCHEV has confirmed officially the existence of an active Soviet manned lunar landing program—a statement widely misinterpreted as a withdrawal from the race with the U.S. to land a man on the lunar surface.

Although some NASA officials fear a stretchout in Project *Apollo* as a result of misunderstanding of the Soviet leader's statement, it apparently will have no effect on NASA's Fiscal 1964 appropriation bill of about $5.2 billion.

U.S. reaction to the statement, however, adds to the pall of gloom surrounding NASA's chances of getting approval for the $5.6-to-$5.8-billion Fiscal '65 budget the agency says it needs to land a U.S. astronaut on the Moon by the end of this decade.

Khrushchev's statement was made in an interview with a group of touring reporters in Moscow on Oct. 25. It appeared in *Izvestia,* apparently after editing, on Oct. 26. He declared that "we do not want to compete with the sending of people to the Moon without careful preparation."

This was immediately flashed across the Atlantic as a Soviet pullout from the Moon race. Largely ignored in the press reports was the important phrase "without careful preparation."

Completely omitted from many press reports were even more important sentences.

"We are not at present planning flights by cosmonauts to the Moon. Soviet scientists are working on this problem. It is being studied as a scientific problem and the necessary research is being done," said Khrushchev.

The first reaction within Administration, NASA and Congressional circles was that the statement would mean a slowdown in Project *Apollo.*

NASA Administrator James E. Webb even declared that the space agency might have to re-evaluate its program. He said the space agency has "a program that we are pretty sure we can carry out, but it is going to have to be weighed very carefully now."

Other officials reported that a slowdown in *Apollo* might result in more military space funding.

• **Double take**—Once the full text of the Khrushchev statement was available, supporters of the space program began a counterattack.

Dr. Edward G. Welsh, secretary to the White House's National Aeronautics and Space Council, declared that rather than a pullout from the Moon race, "it was the first definitive statement by the head of the USSR that they do have a lunar landing program."

He said it will have no effect on the funding or scheduling for *Apollo.*

The White House official also does not believe it will induce Congress to cut deeper into NASA's FY '64 funds.

As for FY '65, Welsh refused to estimate what effect, if any, the statement might have. He did say, however, that even without considering the statement, "there is a great deal of doubt that Congress will appropriate it."

Looming over the whole situation is the fact that next year is an election year. If there is evidence Russia is slowing down its Moon effort, the NASA budget could be reduced to placate economy-minded Congressmen and voters.

Currently, little belief that the Soviet Union is lessening its Moon goals is voiced among senators who will shortly vote on the Fiscal '64 appropriations bill.

• **Standing fast**—Sen. Allen J. Ellender (D-La.), third-ranking Democrat on the Appropriations Committee, told M/R the Soviet pronouncement would not affect his vote on the appropriation. He indicated NASA probably would get most of what it is asking, although some cuts will be made.

Sen. Milton R. Young (R-N.D.), second-ranking Republican, said he would not trust the Russians, although he favored cutting the budget down towards the House level. He said that even if it were proven that the Russians did not have a Moon program, "We shouldn't pay attention to Russia at all. We must carry forward at the rate we think necessary."

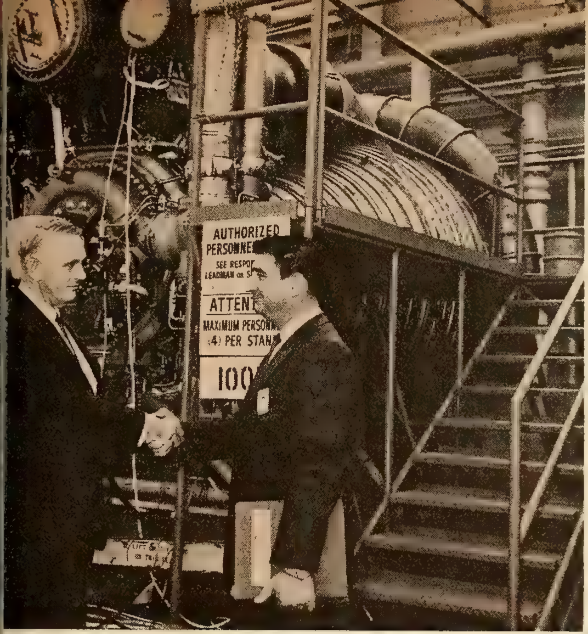
Sen. Warren G. Magnuson (D-Wash.) chairman of the Independent Offices Subcommittee now considering the bill, is known to feel that government spending has a tendency to be wasteful. Thus it can be expected that the Senate may restore up to $200 million to the House Appropriation bill of $5.1 billion, leading to a compromise bill of near $5.2 billion. ■

What Khrushchev Said—In Full

Question: *Can you tell whether a flight to the Moon by Soviet cosmonauts is planned for the not-too-distant future?*

Khrushchev: It would be very interesting to take a trip to the Moon. But I cannot at present say when this will be done. We are not at present planning flights by cosmonauts to the Moon. Soviet scientists are working on this problem. It is being studied as a scientific problem, and the necessary research is being done. I have a report to the effect that the Americans want to land a man on the Moon by 1970-1980. Well, let's wish them success. We shall see how they will fly there, how they will land on the Moon and, more important, how they will start off and return home. We shall take their experience into account. We do not want to compete with the sending of people to the Moon without careful preparation. It is clear that no benefits would be derived from such a competition. On the contrary, it would be harmful as it might result in the destruction of people. We have a frequently quoted joke: He who cannot bear the Earth any longer may fly to the Moon. But we are all right on Earth. To speak seriously, much work will have to be done and good preparations made for a successful flight to the Moon by man.

Budget dictates switch . . .



ROCKETDYNE Vice President J. P. McNamara, left, turns over first production F-1 engine to NASA F-1 Project Manager F. P. Boffola.

Saturn I Decision Will Delay Apollo

First manned flight slips nine months to late 1966, now scheduled to use Saturn IB

by Hal Taylor

NASA'S DECISION to drop manned flights with the *Saturn I* launch vehicle will delay the first manned *Apollo* flight for nine months until the last half of 1966.

The space agency said deletion of the manned *Saturn I* flights would save $50 million and allow it to stay within the limits of its Fiscal '64 $5.3 billion budget authorization.

While admitting that the program change will slip the first *Apollo* launch by nine months, the officials said that U.S. astronauts will be able to gain the same flight experience in the *Gemini* two-man spacecraft program.

The action drops four *Saturn I* launches of the *Apollo* spacecraft's Command and Service modules.

Instead, the first manned *Apollo* flight will be made in late 1966 using the *Saturn IB* vehicle, which will boost all three *Apollo* modules.

The *Saturn IB*—capable of placing 16 tons in Earth orbit—uses the same first stage as the *Saturn I,* composed of eight H-1 engines. Its second stage, with one J-2 liquid hydrogen engine developing 200,000 lbs. thrust, however, is far more powerful than the *Saturn I's* second stage, which used six Pratt & Whitney RL-10 engines with a total thrust of 90,000 lbs.

- **Saturn I was slipping**—While the space agency cited the cost saving as the major reason for the move, slippages in the development of the *Saturn I* also played an important role. NASA had scheduled two flights of the two-stage vehicle this year, but now it is certain that only one will be made. Even that flight may slip into next year.

These slippages would have probably put off the timetable for the first manned *Saturn I Apollo* missions into the same time scale as *Saturn IB* missions anyway.

The dropping of the flights leaves the *Saturn I* with only two space missions—the orbiting of micrometeoroid satellites on its eighth and ninth development flights. Although the first stage will be used in the *Saturn IB* vehicle, its *S-IV* second stage has no other launch vehicle application.

The booster could be used for unmanned space science missions, but this is doubtful. NASA is now studying the possibility of modifying the *S-IB* for such missions by adding a third stage to it.

- **Time savings cited**—The space agency said that "the decision to rephase the *Saturn*-based manned flight missions, based on studies initiated several months ago, was made possible by the success of the four *Saturn I* R&D launchings, the successful ground tests of the liquid hydrogen stages and the J-2 engine."

The decision, it continued, also permits the introduction of a flight test concept designed to result in an overall time saving—the so-called concept of all-up testing.

In this approach, launch vehicle stages and spacecraft modules are tested in their final configuration on each flight. Previous planning had called for a gradual buildup of subsystems, systems stages and modules in successive flight tests. "Experience in other missile and space programs has demonstrated that "all-up testing" is the quickest way to reach final mission objectives, NASA said.

The six remaining *Saturn I* development flights will be carried out to provide vehicle development data essential to the *Saturn IB* and *Saturn V* programs, as well as to gather important information on micrometeorites, the announcement concluded.

- **Production F-1 delivered**—In other launch vehicle development, the first production model of the F-1 rocket engine was turned over to NASA Oct. 28 by its manufacturer, Rocketdyne Div. of North American Aviation, Inc. (see photo).

The huge engine, which weighs more than 10 tons and develops 1.5 million lbs. of thrust, was flown by special aircraft to the NASA-Marshall Space Flight Center.

Five F-1 engines will provide 7.5 million lbs. of thrust (about 160 million horsepower) for the first stage of the *Saturn V,* which will launch the *Apollo* spacecraft on the manned lunar missions.

The engine will be ground tested at Marshall beginning later this year.

Design and development of the F-1 has been underway since January, 1959. Delivery of engines under a production contract awarded last year will continue into 1966.

The first production model of another rocket engine, the hydrogen-fueled J-2 for the second and third stages of the *Saturn V,* will be delivered later this year.

Development of the *Saturn* engines and stages is under the direction of the Marshall center. ■

Test due in IMP launching . . .

System Could Improve Orbit Gauging

NEW YORK—Delivery this week of a new computer program to NASA's Goddard Space Flight Center could signal forthcoming improvements in space-vehicle orbit determination and major refinements in basic spatial measurements.

Developed by scientists at Sperry Rand Corp.'s Great Neck, N.Y., facility under a $190,000 GSFC contract, the program, written in Fortran, makes use of a recently developed mathematical approach called the Minimum Variance Method.

The first program, operating with an IBM 7094 computer, will get its first shakedown in connection with the launching of the *Interplanetary Monitoring Probe (IMP)*, expected later this month. Its use with *IMP*, with inputs from the Minitrack network and two stations of the GSFC range and range-rate system, will give some indication of the program's capabilities for real-time orbital determination.

However, NASA scientists at Goddard emphasize that the program was developed primarily as a research tool for maximum-precision post-flight analysis using a wide variety of tracking inputs. Project officials also point out that with increased information regarding speed and accuracy trade-offs, the Sperry program could indeed form the basis for "a very good real-time computer program."

In the Minimum Variance Method, developed largely by Dr. R. E. Kalman of Martin Co.'s Research Institute for Advanced Study, orbital calculations are continuously based on most recent data inputs from NASA tracking systems, and also build extensively upon previous orbital estimates.

Both NASA and Sperry Scientists are hopeful that the potential accuracies of such a program will lead to more precise determination of the astronomical unit, exactly locate ground-based tracking sites, establish the position and gravity fields of the planets, provide an additional figure on lunar mass and new figures on light velocity.

Many of these measurements, in themselves, are critical to accurate computation of spacecraft orbits. Sperry scientists say that such measurements can be solved for simultaneously with a single computation, and that error pattern recognition allows proper sorting of error sources.

- **Only the beginning**—The program being delivered this week is classed as "abbreviated" by Sperry—abbreviated in that its reported orbital determination accuracy will be limited to "one part in a million"—and it will have certain orbital—parabolic—limitations. An "unabridged" program with greater capabilities for various trajectories—and accuracies allegedly of one part in a billion—is slated for delivery next July. This program will perform the bulk of the primary research.

- **Pinpointing**—Sperry says that with the complete ODP—Orbital Determination Program—space vehicle orbits can be ascertained with a precision 100,000 times more accurate than scientists can now gauge the orbits of the natural planets. Translated into actual distances, one part in a billion means positional accuracies of about 1 ft. at lunar distances, 12 ft. at Venus, and 17 ft. at Mars.

Computer sub-routines are carried out to one part in a quadrillion and then rounded off to give a final precision of one part in a billion. The actual accuracy of the program is greatly dependent upon the initial accuracy of tracking inputs fed into the computer complex. Calculations yielding the highly precise data Sperry says is possible are based upon primary use of the sophisticated range and range-rate system now being completed for NASA by Motorola's Military Electronics Div., Scottsdale, Ariz. The R&RR system which is now partially operational (M/R, March 12, 1962, p. 22) reportedly will have range resolution capabilities of ±15 meters and range-rate resolution of 0.1 meter per second. ■

NASA Overhauls Manned Flight Office

GEORGE M. LOW has been named chief deputy to NASA Associate Administrator for Manned Space Flight, Dr. George M. Mueller, in a major reorganization.

Reorganizations were also effected in the Office of Advanced Research and Technology and the Office of Space Sciences and Applications.

Low, now deputy associate administrator for Manned Space Flight, assumed his new position Nov. 1. He formerly served as deputy director for manned space flight missions.

Walter C. Williams was named earlier to the newly created position of Deputy Associate Administrator for Manned Space Flight Operations.

Three new program offices have also been established. Dr. Mueller will serve as acting director of the *Apollo* program office and Low will be acting director of the *Gemini* office. Each will be responsible for all aspects of his program.

The other office, Advanced Manned Missions, will be directed by E. Z. Gray. He will coordinate and control studies of manned Earth-orbital missions, advanced manned lunar missions and manned planetary missions.

Three offices will be responsible for coordinating general administration for the Office of Manned Space Flight and—at the Headquarters level—for the three principal field centers involved. They are:

—Manned Space Flight Center Development—Robert F. Freitag, director, responsible primarily for field center resources.

—Manned Space Flight Program Control—William E. Lilly, director, responsible for budgetary, financial and facilities matters.

—Manned Space Flight Management Operations—Clyde Bothmer, director.

- **Further changes**—In another reorganization at NASA Headquarters, Boyd C. Myers Jr. was named deputy to the Associate Administrator for Advanced Research & Technology, Dr. Raymond Bisplinghoff. His title will be deputy associate administrator (Resources and Field Operations).

In the reorganization of the Office of Space Sciences and Applications, Edgar M. Cortright was named deputy associate administrator. Dr. John F. Clark was named director of the space science office.

Sponsored by NASA, AAS . . .

Physics of Solar Flares Dissected at Symposium

Students of this 'art striving to become a science' attempt to resolve questions on origin, growth and death of flares

by William Beller

THE PHYSICS of solar flares—a discipline looking for a theory—was examined last week by nearly 200 scientists who met at Goddard Space Flight Center for a three-day international solar flares symposium.

Co-sponsored by NASA and the American Astronomical Society, the symposium did not resolve the causes of solar flares, nor how they grow and die. Nevertheless, leads to possible answers were contained in papers giving detailed solar data obtained from ground observations, rocket probes and satellite flights.

The present solar flare picture was clearly painted by J. P. Wild, Radio Physics Laboratory, Sydney, Australia, who told the symposium, "The basic mechanisms and sources of energy of these (solar) phenomena present perhaps the major current challenge of solar physics."

- **A 'fire hose' theory**—Some future astronaut flying in interplanetary space may be relieved to know if he can't see a solar flare, it won't harm him. This means no matter how actively the far side of the solar disc sends out cosmic-ray particles, none will irradiate him.

This idea contradicts the commonly held concept of isotropic diffusion of solar flares, which says once particles are ejected, they migrate around the solar disc like a cloud, having the same density no matter in what direction they are measured. It appears now that there is a "fire hose" or anisotropic diffusion of the ejecta.

This interpretation was verified by William R. Webber, assistant professor of physics at the University of Minnesota, who told of cataloguing 80 solar events during an 11-year cycle. Eleven Earth years constitute one solar year. He saw only two questionable events whose source could have been on the Sun's hidden side—or far more likely, whose source was on the facing side, but could not be discerned. "Consequently, it's impossible . . . better say, 'highly unlikely,' to have an isotropic diffusion of solar cosmic rays," he told MISSILES AND ROCKETS.

- **What is a flare?**—Solar flares are poorly described from a scientific point of view. A current definition says they are "transient brightenings of areas in the chromosphere." How much brightening and how much area are questions each observer must answer for himself, particularly when the brightenings are small.

A way to a better definition of solar flares may result from the emphasis given to their non-visible character in the radio, extreme ultraviolet and X-ray bands of the electromagnetic spectrum.

Since World War I, the radio signatures of solar flares have been studied throughout the range of their wavelengths able to pass through the Earth's atmosphere—from about 4 mm to about 60 meters.

Different kinds of bursts occur at different wavelengths, according to Wild, because they originate in different layers of the Sun's atmosphere: short waves (wavelengths of millimeters or centimeters) are excited low down near the base of the solar atmosphere (the chromosphere); long waves (meters or decameters in length), high up in the tenuous corona.

Wild says that the radio waves are excited by electron streams and shock waves traveling up from the seat of the flare. He suggests that by studying their characteristics—their spectrum, polarization and precise direction of origin (all requiring specialized new techniques)—a knowledge of flares may be deduced.

For very large flares, Wild puts forth the following sequence of events:

(1) A small region of the Sun's lower atmosphere, close to sunspots, gradually warms up during several minutes;

(2) A sudden, impulsive release of energy (the "flash phase") occurs in the same region. It is manifest by a series (typically about 10 in number) of sharp bunches of electrons with energy around 100,000 electron volts. These travel at speeds of up to about half the speed of light both downward toward the photosphere, causing the excitation of short radio waves and X-rays, and upward through the corona, exciting meter radio waves;

(3) At about the same time, a powerful blast wave, or a succession of them, begins to move out from the center of the disturbance at a much slower speed of some 1,000 km/sec. The detailed progress of the blast wave can be traced by the meter radio waves it emits. The same blast wave is believed to be responsible for several profound effects, namely:

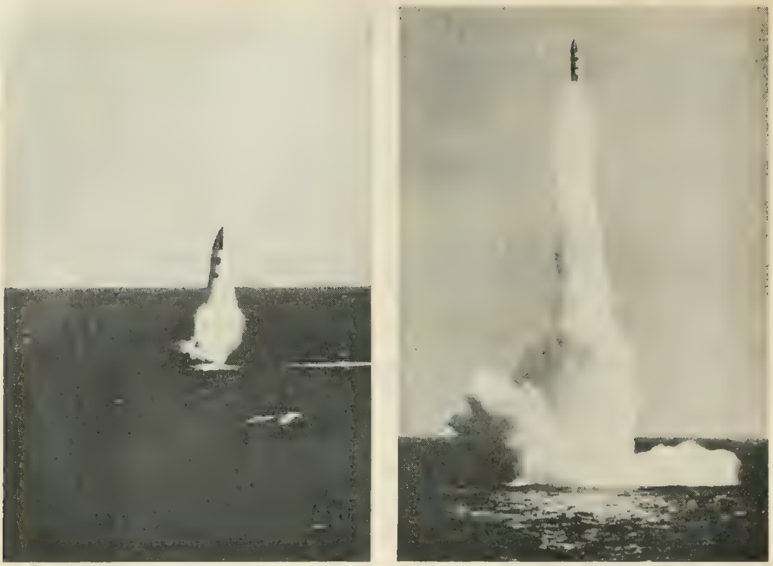
(a) the acceleration of solar electrons, which are trapped in the Sun's magnetic fields and which generate long-lasting (hours or days) storms of radio emission,

(b) the acceleration of solar protons to sufficiently high energies to allow their escape and subsequent detection, minutes or hours later, as they cross the Earth's orbit,

(c) the generation of magnetic storms and aurorae 1½ to 3 days later on the Earth.

- **The Gold concept**—Any theory of solar flares must explain how energy is first stored in the solar atmosphere, then released in sudden bursts. The consensus at the symposium was that the phenomena are connected with instabilities in solar magnetic fields.

Observations bear out this concept. Thomas Gold of Cornell University's Newman Laboratory of Nuclear Studies summarized the findings: flares occur only in regions of strong magnetic fields and predominantly in regions of complex magnetic fields. The highest probability of having a flare occurs when fields are changing rapidly, and this will be expected if a flare represents the transition from a stable to an unstable configuration. ■



A-3 FIRED from submerged Andrew Jackson Oct. 26 hit target area over 2,000 mi. away.

Bigger payload . . .

Navy Seeks Approval For Polaris Follow-on

by David C. Breasted

THE *B-3*, potential successor to the *Polaris* missile family, broke surface last week with public acknowledgement that the Navy is pressing for early Dept. of Defense approval.

Navy comment, hitherto withheld, on the proposed new missile came after the successful first firing of the *Polaris A-3* from a submerged submarine.

A decision is expected within the month on whether to request initial R&D funds in the FY 1965 budget. Timing is a central question, since the *A-3* will not go on patrol until next August to begin its useful life.

Officials of the Office of Director of Defense Research and Engineering declined to estimate how much initial funding would be involved if it is included in the budget. The *A-3* began its development life with $70 million for the first year.

- **Boosting payload**—Increased payload, rather than range, is the primary aim of the *B-3* developers, declared Rear Adm. I. J. Galantin, Special Projects director.

"The range is not as valuable to the submarine system as it is to a fixed system, so it's the payload and how we would slice it" that concerns his staff, Galantin said, "and we haven't settled upon where we'll put that extra capability."

One possibility would be additional equipment to further confuse the opposition.

DDR&E evaluators could not comment on percentage of payload increase. But Fred A. Payne, Jr., deputy director for strategic and defensive systems, said "it is substantial or we wouldn't be fooling with it."

Payne said of the highly-detailed *B-3* proposal "we know it can work," indicating satisfaction with the technical proposals. What the money men think the *B-3* can do remains to be seen. However, Pentagon sources pictured the question as one more of when than of if.

Galantin told a press conference after the *A-3* firing "I am quite confident that one day we will be producing *B-3's* but that (it) is not now an approved program. It does not have to be. The *A-3* is still to be exploited."

Payne said the *B-3* is being "seriously considered" and also considered for inclusion in the '65 budget.

He said that "no big invention" would be involved in developing the *B-3*. Solid-propellant improvement would continue to be the main avenue to putting more muscle in the missile. Reduction of the inert content and beefing up the active ingredients has been one of the main contributions in progressing to the *A-3*.

- **Longest yet**—The successful *A-3* firing from the U.S.S. Andrew Jackson Oct. 26 off Cape Canaveral was described as completely satisfactory. It covered 2,000 n. mi., the longest *A-3* shot to date, according to the Navy. Trajectory height was about 400 mi.

The shot was also the first to use the Mark 84 fire control system with the *A-3* from a submerged submarine.

There was only one minor hold in the countdown, for 44 minutes. It was caused by a faulty water pressure gauge reading in the submarine.

The missile carried telemetry, AZUSA transponder, C-band radar, destruct package, and SOFAR bomb for impact detection in a target area ringed with sonobouys downrange.

One more firing from the Jackson remained possible until the U.S.S. Daniel Webster arrives to begin training with the *A-3* next year. Thirteen more test firings of the *A-3* are planned. The Oct. 26 firing was the 27th firing, the 17th termed successful, and the 14th consecutive success.

With the first five boats retubed, 27 of the 41 planned *Polaris* subs will carry the *A-3* initially. Five Ethan Allen- and eight Lafayette-class subs will receive the *A-3* later.

- **Jobs for A-1's**—In another *Polaris* development last week, the Air Force announced that it will use surplus *Polaris A-1's* in the "Stellar Acquisition Feasibility Flight" (STAFF) feasibility test program. Refitting of the U.S.S George Washington will give the Navy a slight surplus of operational *A-1* missiles. The Air Force reportedly will use about a half dozen in the program which will test stellar sighting in inertial guidance correction in flight.

STAFF, part of the stepped-up effort on the *Mobile Medium Range Ballistic Missile (MMRBM)*, will be the first to use surplus solid ballistic missiles The *Polaris* solid-propulsion system wil be usefully similar in performance to what may develop for the *MMRBM*.

Lockheed will modify the *A-1's* for the test packages and fire them from the *Polaris* complex at Canaveral. Genera Precision, Inc., is developing the acquisition equipment, and Space Technology Laboratories the test sections to contain the packages. ■

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE (AF-DCA-Army)	GE, Philco-STL; definition studies under evaluation	Multiple-launch, active repeater ComSat; 24-36 satellites in 5000-12,000 naut. mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster	One of two systems resulting from re-oriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966
COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	24-hour, station-keeping, active repeater ComSat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA	Second system evolved from ADVENT; initial capability, 1964; operational, 1966
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program
DYNA-SOAR (X-20) (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link; Sundstrand, auxiliary power; Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system. Project ASSET, McDonnell	Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	Development; funded at $125 million in FY '64; manned orbital flight planned after drop tests
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 700- to 805-mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital	ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful. Orbital launch from PMR planned January, 1964
GEMINI (NASA)	McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Minneapolis-Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENA will be used for rendezvous missions. 15 spacecraft will be produced	Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, early 1964. Manned and rendezvous flights, 1964-65; AF participation in program has been approved; this could add 4 to 6 more spacecraft to the program
INTERPLANETARY MONITORING PLATFORM (NASA)	Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit	125-lb. satellite launched into deep-space orbit with an apogee of 172,000 miles. It will measure radiation and solar flares in advance of Project APOLLO hazard. Launched by DELTA booster from AMR	Program calls for eight satellites. Launches will begin late 1963. Later flights will use a nuclear power unit as replacement for solar cells
★**LUNAR ORBITER PHOTO CRAFT** (NASA)	None selected	800-lb. spacecraft launched by ATLAS-AGENA will orbit Moon taking pictures of lunar surface	Contractor to be selected before the end of the year; five flights scheduled beginning in 1966
LUNAR LOGISTICS VEHICLE (NASA)	None	Spacecraft to carry support payloads to the Moon. Two designs under study, LEM Truck and logistics spacecraft with 25,000-to-30,000-lb. payload	Program decision expected 1964. No funding expected until FY '66; program would cost about $1 billion
★**MANNED ORBITING SPACE STATION**	NASA has awarded 12 study contracts; AF study contractors selection due shortly	Manned space station for testing components and techniques in the space environment. Design under study by NASA and AF	NASA and AF contending for program. Decision expected late 1964. NASA and AF both awarding study contracts. Flights in post-1967 period
MARINER (NASA)	JPL, prime	550-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1000-lb. MARINER B also under development	Twelve shots planned. First scheduled Venus fly-by August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus Dec. 14; two Mars fly-by missions planned in late 1964
MDS (NASA)	Fairchild Stratos, prime	3400-lb. meteoroid detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit, 300 to 800 miles; booster SATURN 1	Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch scheduled for mid-1964; two will be orbited
MERCURY (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY made 22-orbit flight with L. Gordon Cooper on May 15. Program now completed
MIDAS, PROGRAM 239A (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads	Development; re-oriented system now funded for total of $450 million; funding of $150 million for FY '63 now cut to $100 million for FY '64

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**NIMBUS** (NASA)	Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras	2nd-generation weather satellite; Earth-stabilized polar orbiting; 750 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for early 1964; second, six months later; two R&D satellites
OAO (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage	3500-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, ATLAS-AGENA D	Three flights beginning in 1965
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA D, CENTAUR boosters	First flight scheduled in early 1964; 19 experiments planned for first shot; five other flights planned
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; DELTA and ATLAS-AGENA boosters, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; five more flights planned; advanced OSO to be built by Republic
PIONEER (NASA)	STL	120-lb. spin-stabilized solar probe; DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; 4 outrigger booms for stabilization; 5 experiments, 60-to-90-million-mi. communication capability	Seven launches in program; early 1965 launch schedule set; orbits range from .8 to 1.2 au for 6-mo. lifetime
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket; Northrop, serving as support contractor, will be named prime in 1964	300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster	R&D RANGER VI launch postponed; program undergoing management change; five more RANGERS added to program—making a total of 14; plans call for a total of 22; next launch, first quarter 1964
★**RELAY** (NASA)	STL, project coordination and systems planning; RCA, prime	172-lb., spin-stabilized, wide-band, 700-4000-mile orbit active repeater experimental communications satellite. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; RELAY II January, 1964
SATELLITE INSPECTOR (SAINT) PROGRAM 706 (Air Force)	RCA, prime; Hughes, detection equipment	Anti-satellite inspection system also capable of destroying hostile vehicles	R&D; re-oriented; 3 study contracts to be awarded to determine characteristics of a SAINT vehicle, based on a manned system using GEMINI capsule
SAMOS (Air Force)	Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300-mile circular polar orbit	Operational; advanced SAMOS under development; FERRET version used for electronic intelligence and communications eavesdropping
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched in late 1963
SLOMAR (Air Force)	Lockheed, Martin studies completed	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded December, 1960; DOD studying concepts in connection with Manned Orbiting Development Station
SURVEYOR (NASA)	Hughes, prime; Martin, SNAP device	2100-lb. spacecraft for soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; Moon-orbiting vehicle planned; SNAP nuclear generator optional	First Moon flights early 1965; seven soft-landing vehicles planned
SYNCOM (NASA)	Hughes, prime	24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in dia. and will weigh about 55 lbs.; capable of accommodating one full duplex radio telephone channel	First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost. SYNCOM II launched July 26, 1963, completely successful. 500-lb. advanced SYNCOM to be developed
SMS (Synchronous Meteorological Satellite) (NASA)	Republic, study contract	24-hour weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or CENTAUR	First flight 1966; No development funding in Fiscal '64 budget
TELSTAR (AT&T-NASA)	BTL, management for AT&T	170-lb., active repeater, experimental industry communication satellite; DELTA booster	Development; first launch July 10, 1962, highly successful; second launch May 7, 1963, also successful
★**TIROS** (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (3000-mi. apogee)	R&D; seven satellites launched; all successful. Next launch December, 1963. Seven more added to program (4 R&D NASA, 3 operational, Weather Bureau)

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TRANSIT (Navy)	Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers	Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; SCOUT booster	Operational system in process of being established for use by POLARIS subs; NASA also will use TRANSIT for civilian navigation satellite system
★**VELA HIGH ALTITUDE** (ARPA)	STL, prime; Los Alamos Scientific Lab Aerospace, payload	20-sided, 485-lb. satellite for detection of nuclear explosions in space; 50,000-n.-mi. orbit; booster, ATLAS-AGENA	Initial launch planned for twin satellites in September or October
VOYAGER (NASA)	Study contracts, Avco Corp. & GE	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface	Funds may be in FY '65 budget. Launches in 1968-70 period. Spacecraft of 6000 lbs. to be launched by ADVANCED SATURN
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics	Manned rocket plane; capable of 4000-mph plus flight at edge of space; each rocket engine develops 57,000 lbs. thrust; re-entry flights providing data for X-20	Powered flights in progress; unofficial records set: altitude 354,200 ft. and speed (4104 mph); X-15 will be used as trainer for X-20

Space Vehicles

AGENA (Air Force)	Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion	1700-lb. upper stage; all-inertial guidance; re-start capability	Used in DISCOVERER, SAMOS and MIDAS programs; ATLAS, THOR boosters
BLUE SCOUT (Air Force)	Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	4-stage vehicle; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance	Operational; based on NASA's SCOUT; space probe and small (150-lb.) satellite launch vehicle; also AF's Hyper-Environmental Test System
CENTAUR (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX/liquid hydrogen engines; 30,000 lbs. total thrust, ATLAS D booster, capable of orbiting 8500 lbs.; 2300 lbs. to escape; 1300 lbs. on planetary flights	Development; program responsibility transferred from MSFC to Lewis; first flight test failed; late 1964 or early 1965 earliest possible operational date; next launch November, 1963
★**DELTA** (NASA)	Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3-stage vehicle; 430 lb. payload capability in 500-mile orbit; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively; THOR missile comprises first stage	Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational this year; THRUST-AUGMENTED DELTA with 3 solid motor strap-ons also will be used
★**LITTLE JOE II** (NASA)	General Dynamics/Convair, prime	Solid-propelled vehicle with thrust of 800,000 lbs.; launch vehicle for APOLLO suborbital flights	First launch Aug. 28, 1963, successful; six vehicles ordered thus far
★**NOVA** (NASA)	Martin, study	Capability of NOVA under study; no firm concept but should offer significant improvement over C-5 (20-30 million lbs. 1st-stage thrust or nuclear upper stage)	Study to determine characteristics; operational target date post-1970 time period
ORION (Air Force)	General Atomic	Space booster propelled by series of atomic explosions to lift over 1000 tons into orbit	Studies; AF FY '64 request for $9.8 million denied by DOD; R&D continuing with funds re-programmed from FY '63
ROVER (NASA) AEC)	Los Alamos Scientific Labs, ROVER Prime; Lockheed, RIFT vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion	First nuclear rocket: tests of KIWI, prototype of NERVA engine, under way	First ROVER flight test expected before end of decade
SATURN I (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO. 1st stage: 8 Rocketdyne H-1 engines; 2nd stage: 6 Pratt & Whitney RL10-A3 engines; 22,000 lbs. into 345-mi. orbit	Four flight tests of 1st stage successful; all flights with inert upper stage; first flight with live upper stages October-September, 1963
SATURN I-B (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas	S-1: 8 H-1 engines; S-IVB: 1 J-2 engine; payload capability, 32,000 lbs. in 345-mi. orbit	Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle
★**SATURN V** (Advanced Saturn) (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-IC, Boeing; S-II, North American; S-IVB, Douglas; F-1, North American; J-2, North American	S-IC: 5 F-1 engines; S-II: 5 J-2 engines; S-IVB: J-2 engine; 120-ton payload in 345-mile orbit; 43 tons to escape velocity; 30 tons for planetary missions	R&D; first flight scheduled for 1966; prime booster for APOLLO missions; may also be used to boost orbiting space station
SCOUT (NASA)	L-T-V Astronautics, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 300-lb. payload in 345-n.-mi. orbit	Operational payload being increased to 300 lbs.; NASA has ordered 23 more boosters
TITAN III (Air Force)	Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance	Quick-reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, two 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance	Development; first flight late '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned: 5 TITAN II core vehicles (A version), 12 full TITAN III's (C version); operational in 1965; 120-in. solid fired successfully July 20

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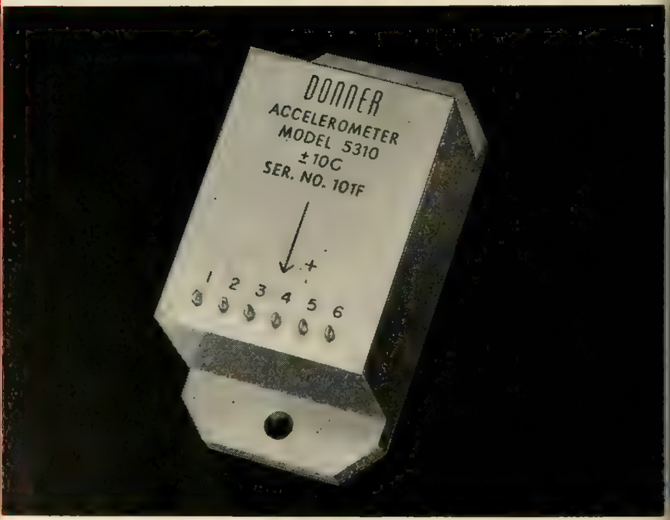

Flexure Accelerometer Model 5310

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Technical Countdown

ADVANCED MATERIALS

New Design Theory for Filament Winding

Research scientists at Philco's Aeronutronic Div. have evolved a fundamental design theory for filament-wound structures. The new theory, disclosed in Paris at the recent 14th International Congress of Astronautics by Aeronutronic's Dr. Stephen W. Tsai, compensates for two heretofore ignored factors. These are the different characteristics of the two materials involved—resins and glass filaments—and the variance of mechanical properties depending on orientation. Work is in progress to uncover all the implications but the researchers feel the new theory will enable U.S. designers to construct filament-wound structures with a higher degree of confidence that theoretical predictions will match actual performance.

1,000° F Maraging Steel Perfected

A new type of maraging steel is under development at International Nickel's Research Lab., Bayonne, N.J. The steel combines most of the desirable characteristics of the established maraging materials with a yield strength of 180,000 psi and stress-rupture life up to 100 hours or more when subjected to a stress of 100,000 psi at 1,000° F. Optimum 1,000° F properties were achieved with a maraging steel containing 15% Ni, 9% Co, 5% Mo, 0.7% Al, 0.7% Ti and the balance Fe.

Molybdenum Workable at Room Temperature

Molybdenum rod effectively free of interstitial impurities is in production at Materials Research Corp. of Orangeburg, N.Y. The triple-pass electron-beam-refined rod may be plastically deformed into foil and wire at room temperatures. Resistivity ratios considerably in excess of 10,000 have been measured for this material. It is estimated that the total interstitial content is less than seven parts per million.

Low Cost Al Spot-Welding Process Developed

A technique involving standard gas metal arc-welding equipment at Aluminum Corp. of America produces joints requiring no pre- or post-weld processing. The completed welds resemble riveted joints in appearance, but display better electrical conductivity. The Alcoa R-305 process uses a lap-joint design with the aluminum being the bottom piece and any of a number of metals on top. The nozzle of the electrode holder is placed against the top surface of the joint and the arc is energized. Aluminum filler metal pushes through the softening top layer and bonds to the Al base. The filler metal hardens, forming a fused rivet.

ELECTRONICS

Minuteman Electronics Reliable

Data from 500,000 operational hours with installed *Minuteman* electronic systems show that failure rates have been better than predicted by 35%, says Autonetics, prime contractor for the ICBM guidance and control system.

Wing Six Computer Extends Range

The *Improved Minuteman's* digital computer has 2.5 times the capacity of the present missile's computer and half the weight. Range increase attributable to computer weight-saving amounts to about 170 miles. The computer's functions include pre-flight testing, countdown, staging, and control of penetration aids such as decoys or radar chaff, in addition to flight-path control.

Platform Inertial vs. Strapped Systems

Strapped-down inertial systems can compete with platform systems in accuracy, concludes Jerry C. Powell, Aeronautical Div., Minneapolis-Honeywell, but overall reliability will still be dictated by the reliability of the inertial sensors. As the size, weight and power requirements of associated computer hardware are reduced, the strapdown concept becomes more attractive. At present, the computer vs. gimbal trade-off in terms of size, weight and power may be slightly in favor of the strap-down system. For long-term navigation, a high-speed, special-purpose computer is probably required to make such systems practical.

Only Accelerometers?

Analysis of satellite attitude control and determination of orbital parameters indicates feasibility of an accurate system using only accelerometers as sensing instruments, according to Avionics Div. of Bell Aerosystems Co. H. Winter told the Air Force Symposium on Ballistic Missile and Space Technology at San Diego that it is possible to provide a seven-accelerometer system with a vertical error of less than 30 minutes of arc, an azimuth error of 40 minutes, error in determination of semi-major axis less than 30 km and error in determination of eccentricity less than 0.004.

PROPULSION

New Propulsion Safety Methods Urged

There is a need to establish rocket propulsion safety design criteria for manned space vehicles in several areas, according to investigations conducted by the Rocket Propulsion Laboratory at Edwards AFB, Calif. Specific areas include: incorporation of a pressure relief for compartmental areas to prevent structural damage due to the overpressurizing conditions; proper shielding or encasement of potential ignition sources to prevent impingement of propellent vapors on hot sources which could trigger a fire or explosion; and safe disposition of combustible vapors external to the vehicle by means of pressurizing the compartment with inert gas during a mission and prior to re-entry.

Titan III Error System Described

A hot wire designed into the Air Force *Titan III* launch vehicle will help provide pilot safety insurance. The wire, carrying 28 volts dc, will be routed through the vehicle to sense several areas strategic to pilot safety, including premature staging, loss of power, solid motor thrust termination and inadvertent destruct.

Thiokol To Handle Titan III Destruct

A safe-arm device designed to initiate signalled destruction of the *Titan III* booster system in the event of launch malfunction will be developed by the Bristol Division of Thiokol Chemical Corp. The $90,732 contract from Martin-Denver covers design, development and fabrication of the destruct system for the Air Force solid/liquid booster.

Improved Polaris Fire-Control System Going to Sea Duty Shortly

First Mk 84 unit to be deployed aboard U.S.S. Lafayette; first submerged A-3 firing off Canaveral uses GE-designed system

by Michael Getler

WHEN THE NAVY adds the 7,000-ton U.S.S. Lafayette to its on-station *Polaris* firing line within the next several weeks, it will mark not only the addition of the first vessel of the largest class of *Polaris*-carrying submarines, but the introduction into fleet use of a highly advanced fire-control system.

The 425-ft. Lafayette (SSBN-616), the eleventh FBM submarine to take up station, in combination with the new Mk 84 fire-control system will be able to fire all three generations of *Polaris* missiles.

First submerged firing of an *A-3* version, made Oct. 26 off Cape Canaveral (see p. 18) from the U.S.S. Andrew Jackson, also was the first use of Mk 84 for such a firing with the advanced *Polaris*.

Navy's Special Projects Office has guided requirements for the on-board fire-control system, as it has for the entire *Polaris* weapons system development. The new system and its predecessor, the Mk 80, were designed and built by General Electric's Ordnance Dept. in Pittsfield, Mass., with Hughes Aircraft Co. brought in as a second source on the Mk 84 project. More than 300 subcontractors support the prime effort, and the Mk 80 team is largely intact on the Mk 84.

Navy management experts told M/R that the service has reaped major economies and performance improvements throughout the entire *Polaris* development effort by extensive use of second-source methods (M/R, Oct. 7, p. 40).

The first 10 FBM submarines carry the GE-developed Mk 80 system. While the Mk 80, still judged to be a highly effective system, will not be replaced with the new Mk 84 systems, the earlier systems, Navy sources report, will be modified to handle the advanced *A-3 Polaris*.

As a submarine-based fire-control system, the Mk 84 marks several major advances in system design and flexibility and it's basically an etxension of the techniques which have paid off greatly for the Navy throughout the entire *Polaris* program.

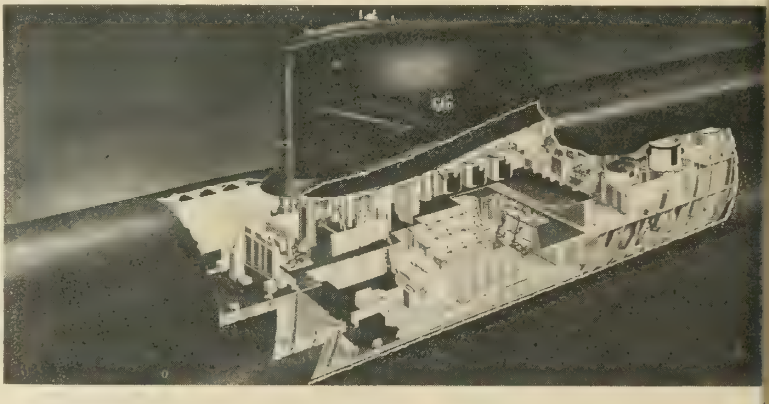
- **Computer heart**—The key operational advantage of the Mk 84 is tied to the introduction of a new digital geoballistic computer—DGBC—to the system. This will give *Polaris* crews digital target trajectory computation capabilities while on station, making the entire weapon system independent of any external support. The new DGBC also will have analog capabilities.

The earlier Mk 80 is also basically a composite system, but with essentially no on-board digital computation capability. With the Mk 80, while new or altered targeting programs can be fed into the missiles on station, shore-based support is required for the necessary prior computation.

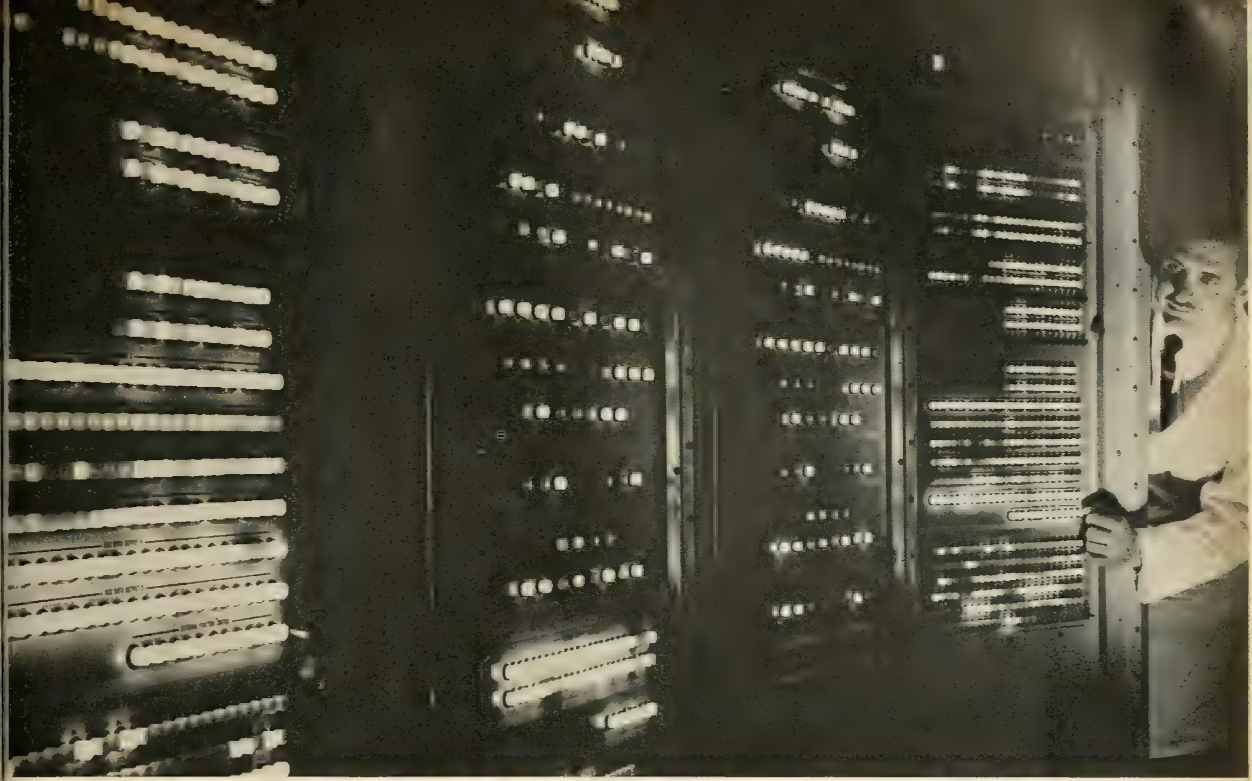
Equations on the ballistics of *Polaris* are initially generated in all cases by shore-based computations and reduced to a computer program for the shipboard DGBC. Target trajectory is automatically revised as the ship moves. However, the key to the new Mk 84 flexibility is that the digital calculations can now be made on-board for newly assigned targets with an entirely new target program inserted in the DGBC and checked out "within a few minutes."

The DGBC, Navy sources told M/R, is actually a "militarized" version of Control Data Corp.'s "1604" commercial computer. The Mk 84 system has an 8,000-word, 24-bit storage capability, with a 6-microsec. cycle time and a 2-microsec. access time. The system has a 2.5-megacycle split-phase, alternate-access memory.

The Mk 84, in the presence of a submarine environment, receives, correlates, interprets and transmits essential position, flight and target data to each missile guidance system. This data, gleaned primarily from the Ship's Inertial Navigation System (SINS) inputs and target data stored in the DGBC memory, provides the submarine's location, local vertical, true North, target location, initial trajectory and periodic updating until the instant of firing.



CUTAWAY OF SUB in artist's drawing shows Mk 84 fire-control complex in center directly below tower numerals and black-and-white cases which house inertial portion of Ship's Inertial Navigation System. Two operators are shown seated at complex with equipment racks at their backs.



GE TECHNICIAN tests lights on digital geoballistic computer (DGBC) of Mk 84 Polaris fire-control system.

• **Building blocks**—Mk 84 also ıakes major use of modularization building block" design approach and omponent standardization programs /hich are characteristic of the *Polaris* evelopment and which greatly ease the roblem of on-board spares and mainteance. Production costs, says GE, are 6% less than the Mk 80 figures. Unit ost for a single Mk 84 is about $2.5 ıillion.

Most of the system's electronics re supported by aluminum door-like rames, about 70 of which make up the omplete fire-control and support secion. These doors, classed as Type-1 ıodules, swing out for access. Mounted n each door are back-panel plug oards, termed Type-2 modules, standrd in design but differing in dimension n some cases. There are 446 modules f this type in the system. GE reports developed a new programmed wirerap machine for internal connections nvolving these modules.

The smallest module is the Type-3, plug-in type containing the individual ircuits and circuit packages. These nits, of which there are 11,000—hough only 200 different types—virually cover the surface of the plug-in oards. Unregulated power supplies are ocated adjacent to the equipment.

GE reports that although more than 00,000 transistors and diodes are used n the Mk 84, there are only 19 different types. The 6,000 relays have been standardized into seven types.

GE says that a complete Mk 84, which is contained in a 23 x 21 x 6½ ft. compartment aboard a submarine, was installed within 18 days last August. The entire system is designed in blocks which are fitted together in sequence after passing through the hatch of the submarine. Whatever wiring and welding is required is done prior to installation. The system, which became operational about three years after development started, is delivered to dockside in reverse order of packing.

• **Better than one a minute**—GE also reports that the Navy will have to train only five men per submarine to run the Mk 84.

The Mk 84's built-in test capabilities include the ability to automatically detect failures down to the Type-2 module level in all cases, and to a small group of Type-3 modules in most cases.

The Mk 84 reportedly readies any type of *Polaris* missile for launching at a rate faster than one per minute. In general, long-duration checklist items—such as tube pressurization, guidance gyro run-up, and fire-control channelized functions—are done in parallel. Final readiness items are generally done serially, with logic circuits on the fire-control console initiating each step to launch after receipt of a status signal. The system will skip a missile found to be faulty, passing to the next one while the fault is isolated. ■

Total of 44 Mk 84 Systems to Be Bought

AT $2.5 MILLION per system, Navy has already purchased 33 Mk 84 fire-control systems. Twenty-five of these are for submarine use, eight are for trainers.

Of the 25 operational systems, 19 have been delivered and six are reported to be on the way.

The Navy will buy 11 more systems, including five to be delivered to the British. Four of the British systems will go into submarines and one will be installed at the training center in Scotland.

Contracts for the remaining 11 systems will be let before the close of FY 1964, the Navy says. Either GE or Hughes could walk off with all 11 systems, or the two firms could share in the fabrication effort. Of the 33 systems ordered to date, GE supplied 23 and Hughes 10.

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PRODUCTION ENGINEER—ROCKET ASSEMBLY
To provide technical support required by Rocket Assembly in areas of methods, tooling, fixtures, and equipment; detailed process studies and design work would be provided through coordination with technical and engineering operations. Responsibilities include manufacturing procedural requirements, acquisition, design and acceptance of tooling, fixtures and equipment; review contracts, drawings and specifications; provide engineers with manufacturing technical systems; assist in creation of cost estimates; review and supervise assembly personnel on assigned production tasks or programs. B.S. mechanical engineering with up to six years experience in field closely related to manufacturing and assembly techniques.

TEST ENGINEER
To plan and design test programs for rocket propulsion systems; prepare schedules and coordinate program to meet schedules; analyze test results and prepare test reports; design mechanical components for measurement systems; plan and coordinate environmental test programs; keep abreast of field of testing and rocket propulsion. B.S., M.S. mechanical engineering or physics with minimum of three years experience, preferably in rocket propulsion field.

DATA ANALYSIS SUPERVISOR
To supervise the work of data technicians in the reduction of ballistic data from tests of propulsion units; present statistical analyses of ballistic data and instrumentation systems in the most meaningful form; assist in planning test programs through statistical design, and keep abreast of fields of statistics and testing. B.S. mathematics with good statistical background

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AF's Orion Program Getting NASA Scrutiny

Development of nuclear-pulse concept for planetar missions would require new look at test ban treat

THE COMPARATIVELY neglected *Orion* nuclear-pulse concept, studied under Air Force contract for five years, is receiving serious NASA attention as a system for higher-energy fast manned planetary missions by 1980. Some NASA sources feel it may be the only practical system for this mission.

Orion advocates hope the nuclear test ban treaty can be interpreted or modified to permit development.

NASA's investigation of what up to now has been a military program started in June with award of a study contract to General Atomics division of General Dynamics. The study is assessing the fast manned mission potential *Orion* may offer for planetary exploration from 1975-1995, and involves analysis of missions to Venus, Mars, Jupiter and moons of the latter two.

The space agency began looking into nuclear pulse, sources told MISSILES & ROCKETS, after some recent studies virtually eliminated all but two propulsion systems—nuclear-pulse and gaseous-cavity reactors—from serious consideration for the heavier-weight fast manned planetary trips before 1980.

Since these studies indicated that solutions to the gaseous cavity approach do not seem likely in the foreseeable future, the *Orion* concept stood out as the system that could meet both the very high specific impulse and high acceleration required for the more demanding mission profiles considered.

NASA spokesmen point out, however, that the investigation leading to this conclusion was only one of many on propulsion requirements for fast manned trips, and that since these investigations are based on different ground rules, different conclusions are reached.

Sides are forming within NASA over the merits of the systems under consideration. NASA spokesmen freely admit that the results of a given stud may very well depend upon the bi of the persons involved. "They'll mak the study come out that way," one tol M/R.

• **Several systems studied**—For e ample, one recent study to evaluat propulsion requirements for a fa Mars orbit rendezvous (MOR) missio pointed to first-generation solid-core nu clear reactor technology (Rover) the best compromise for that mission.

The Office of Manned Space Flig study considered chemical, first- an second-generation solid-core, gaseou cavity, nuclear-pulse, nuclear-electri and fusion systems.

Likewise, the heliocentric orbit re dezvous (HOR) approach to Mars, als under NASA study, would appear to relatively less demanding on propulsio technology, eliminating the need f putting a large weight into Mars orbi Using this method, the large missio module would continue past the plan while a small craft separated for Ma exploration, after which it would launc into the mission module's heliocentr trajectory for rendezvous.

The big question is whether the approaches can be used. Tougher mod for fast manned missions may be nece sary, depending upon spacecraft an crew requirements still to be dete mined.

Several things influence curre thinking on the problem:

—NASA generally is thinking abo component lifetimes of around 10,00 hours, something more than a yea Feeling is that the first manned plan tary flight should not be committed a long transit time or a long waiti period at the target planet. This is contrast to some earlier discussions both industry and NASA of flight tim running considerably longer.

—Landing missions will be mo

costly and technically difficult as Mars mission velocity requirements increase rapidly between 1975 and 1984.

—Nuclear systems will be required.

For missions more demanding than MOR or HOR, including direct flights with very short transit times of about a year and manned landings, the very high acceleration and payload potential of nuclear pulse may be required, according to NASA spokesmen.

For these missions, the solid-core nuclear rocket appears to offer only limited potential, particularly considering the orbital departure weights involved, and upcoming high-velocity requirements, NASA sources state. Nor does nuclear electric propulsion appear available for such missions before 1980 unless system weights can be greatly reduced.

- **Concept examination imperative**—Because these indications have come from studies into the more demanding missions, says NASA, it is considered of prime national importance at this point to examine *Orion's* potential.

According to one NASA source, the nuclear-pulse system appears to have all the characteristics of a system that could produce a quantum jump in the state of the art, perhaps being capable of specific impulses up to 100,000 seconds.

But whether an advance of the *Orion* magnitude will be necessary for fast manned missions remains to be determined. The propulsion capability offered by Rover may be sufficient.

"It depends upon what missions we choose, how heavy a Mars spacecraft would have to be, what radiation and micrometeoroid shielding requirements are, how long man can safely remain in space, whether artificial gravity will be necessary, whether we can use atmospheric or propulsive braking or a combination, what time period is selected, and how quickly advanced systems can be developed," a spokesman said.

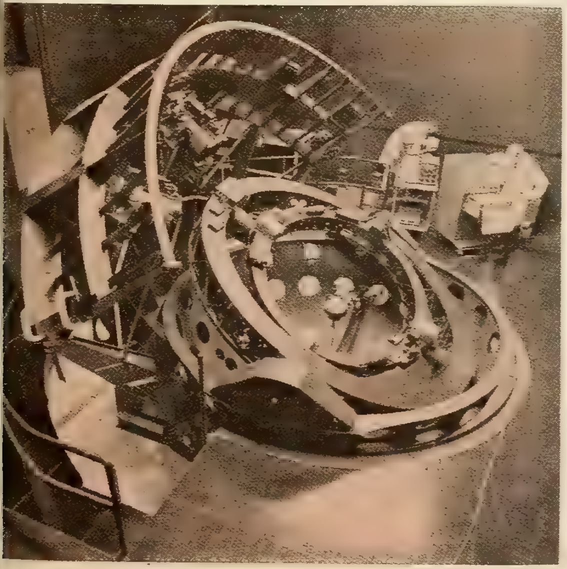
"Everything bears on the propulsion requirement. We won't know the answers until after we have determined these things with a manned space station. If the larger systems are necessary, nuclear pulse would appear attractive."

Meanwhile, the long lead times implicit in development of new systems makes it mandatory for NASA to study requirements of a variety of mission profiles.

- **Treaty modification**—Nuclear-pulse enthusiasts outside NASA would like to see a good case made for seeking a favorable interpretation or even modification of the nuclear test ban treaty to permit *Orion's* development. Some top sources declare there is no question about feasibility in their minds and that the system could enable "single-stage manned planetary missions to accomplish almost anything we want in the solar system," including landings.

With ratification of the treaty, a spokesman said, the nuclear-pulse concept is "stuck in an unfortunate framework that makes it difficult to carry forward. This is through no fault of its own. It is a propulsion system, not a weapon.

"If the nation decides there is an urgent enough requirement, if it decides that opening up manned exploration of the solar system with this concept is worth fighting for—and it ap-



UAC Stellar-Inertial Lab

NEW SPACEFLIGHT simulation lab at United Aircraft Corp.'s corporate systems center will be used to check out new stellar-inertial systems. The 5-ft.-dia. platform, which rides on a 16-in.-dia. air-supported steel bearing, can hold up 1,200 lbs. of equipment. Table provides 360, 110 and 85 degrees mobility around three axes.

A RARE

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ENGINEERS:

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SYSTEMS

ACTIVITY

The Applied Physics Laboratory, The Johns Hopkins University, has prime responsibility for the operational evaluation of the Polaris weapon system, including navigation, fire control, launcher, missile, and submarine.

Several electronics engineers and physicists on all levels are urgently needed to evaluate performance and reliability of equipment operated in its natural environment, to study the equipment and decide when abnormalities exist, and to execute corrections on the spot or collect data for analysis. Results of this program assist those responsible for planning the national weapon deterrent system. Your work will be conducted at APL's modern facilities in suburban Washington, D. C. Some travel to Cape Canaveral will be required.

Direct your inquiry to:
Mr. W. S. Kirby
Professional Staffing

The Applied Physics Laboratory
The Johns Hopkins University

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pears the only likely system at present —we should make a 'peaceful uses' case for it and open an exclusion clause in the treaty.

"Sometime between now and a certain date, the chart shows that we're going to catch up with the Russians in payload capability with conventional systems. But a sudden leap forward, a development that would reduce payload cost by a factor of 1,000 is not difficult to conceive. If the Soviets get it first, it will be a Russian world. Nuclear pulse could be our ace in the hole. We can go only so far with tests using chemical explosives."

Enthusiasts say that inability to release much specific information has prevented wide acceptance of the concept as something more than a novel idea. Harold B. Finger of the Space Nuclear Propulsion Office recently was quoted as saying nuclear pulse couldn't be developed, raising the ire of those close to the program who complained they were unable to publicly defend it against his remark because of security restrictions.

Answering Finger's comment, some sources declare the Rover approach is not worth pursuing when *Orion's* greater theoretical potential over Rover is generally recognized and could provide a wider range of space use.

NASA spokesmen, including Herman Koelle, director of the future projects office, Marshall Space Flight Center, agree that a nuclear-pulse vehicle would be nice to have. But he and others in NASA believe the vehicle raises many serious problems and a substantial development program would be needed to prove feasibility.

• **Orion's potential**—However, sources close to the program say they have no doubts about the system, which has been tested with chemical explosives. They claim that:

—There are no problems extant for which solutions cannot be seen. No development of new materials is required.

—At "considerably lower cost" than the *Apollo* program (but based on *Apollo* accomplishments), the concept can trigger manned missions to Venus, Mercury, Mars and Jupiter by the end of the 1970s.

—The system offers enormous payload improvement over both chemical and conventional nuclear systems, by factors of up to 100 or more over chemical propulsion, depending upon the mission. The payload potential reduces shielding against radiation and micrometeoroids to a relatively routine problem.

—Initial operational capability could be achieved by 1975, perhaps even in half that time, provided work is started now.

—Not the least of its advantages is the inherent operational simplicity and reliability of the "engine." It has built-in stop-start ability, and dispenses with conventional propellants, their complicated systems and their problem of long-term space storage.

—It could boost itself from Earth with quite small fallout from small-yield charges, or using "clean" bombs, eliminating chemical stage boost and orbital rendezvous.

• **Lunar launches studied**—The NASA nuclear-pulse study is outlining possible development programs that would meet the 1975-1995 period.

To meet possible Earth-launch objections, it also is investigating launches of both fly-by and landing interplanetary missions from the Moon. Planetary missions in which the vehicle would be boosted with a chemical stage to an altitude of about 40 miles above Earth also are being developed.

Other portions of the study include design of several typical vehicles that could meet the stated missions, comparison of such systems with other propulsion methods as to feasibility, performance and cost, and determination of growth possibilities, including application of fusion charges. ■

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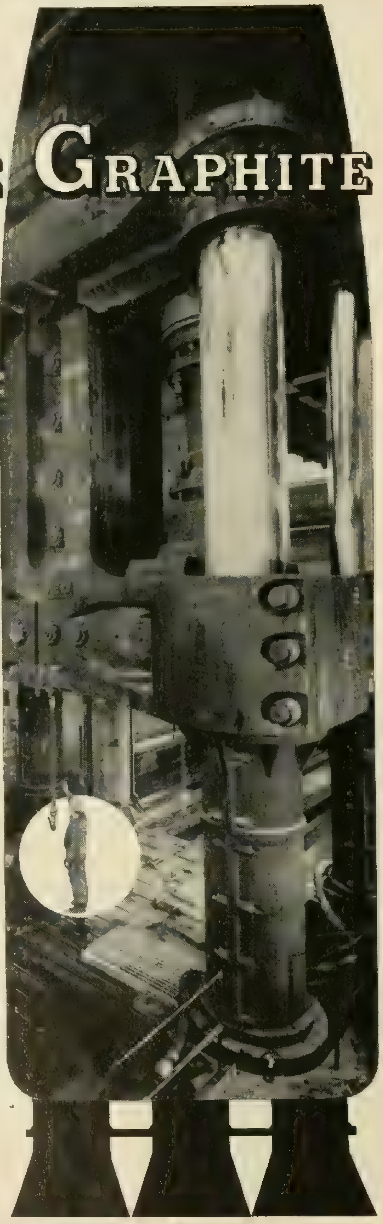

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Circle No. 8 on Subscriber Service Card

The Industry Week

Mergers and Acquisitions

Pyle-National Co., Chicago, electrical and electronic equipment manufacturer, has acquired a financial interest in General Micro-Electronics, Inc., Santa Clara, Calif., a newly established manufacturer of micro-electronic devices. P-N has made arrangements for immediate development and production of the new firm's micro-electronic and integrated circuitry devices for military, industrial and commercial uses. . . . *Waltham Precision Instrument Co., Inc., Waltham, Mass., has purchased the electronic connector product line of Gorn Electric Co., Stamford, Conn. The manufacturing of the connections will be integrated with operation of Waltham's present line of electronic connectors.* . . . American Bosch Arma Corp. and Altamil Corp. board of directors have approved in principle a consolidation of the two companies. ABA develops and produces electronic devices for missile/space and other military applications. Altamil is engaged in production of structural components for missiles and high-speed aircraft. It is also engaged in various other metal-working activities. . . . *Trimflex, Inc., Verona, N.J., has purchased Timely Technical Products Div. of Fluorocarbon Co., Anaheim, Calif. Through the acquisition, Trimflex will become one of the largest processors of Teflon, TFG extrusion, pipelining, special shape extrusions, braided Teflon hose and other fluorocarbon plastics for the missile/space, aircraft and electronics industries.*

New Firms and Divisions

Thompson Ramo Wooldridge, Inc., Cleveland, has changed the names of several divisions engaged in missile/space defense work. Tapco Div. is now known as TRW Electromechanical Div.; Kolcast Div., as TRW Metals Div.; Jet Div., as TRW Jet & Ordnance Div.; Pacific Semiconductors, Inc., as TRW Semiconductors, Inc.; Space Technology Laboratories, Inc., as TRW Space Technology Laboratories. . . . *Bendix Corp. has formed a Micrometrical division at Ann Arbor, Mich., as part of a newly formed Scientific Instrument and Process Control Group, organized for major corporate expansion in the field of scientific and industrial instruments.* . . . Essex Manufacturing Co., Inc., St. Louis, producers of components for the missile/space and aircraft industries, has formed Essex Cryogenics, Inc., also in St. Louis, to specialize in production of cryogenics systems, containers, accessories and components.

Industry Facilities

General Electric Co. has begun construction of a $500,000 addition to its Specialty Control Dept. in Waynesboro, Va. The 27,600-sq.-ft. expansion will be used for development and manufacturing of hermetically sealed relays for missile/space applications. . . . *Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., has installed a $53,000 data acquisition system at NASA's trisonic wind tunnel facility at the Marshall Space Flight Center, Huntsville, Ala.* . . . Commercial Metal Treating, Inc., Bridgeport, Conn., has installed a Model 19L-2-15 Harris Cascade Refrigeration System to supercool metals to —120°F. . . . *Foote Mineral Co., Exton, Pa., plans to consolidate operations of its Niagara Falls Smelting & Refining Div. with its metallurgical processing plant at Exton early in 1964. The move is expected to permit diversification of 'Falls Brand' hardeners and master alloys currently supplied to metallurgical customers.*

Company Representatives

Industrial Products Group of Texas Instruments, Inc., Houston, has opened a new office in St. Paul, Minn. Norman Peterson will head the office. . . . *Hyer Electronics has been appointed Interstate Electronics Corp. representative for Colorado, Arizona, New Mexico and Utah. Hyer will sell all of Interstate's product lines, including VLF receivers, CRT recorders, automatic signal tracking filters and A-to-D converters.* . . . Arnold Associates of Cheltenham, Pa., has been appointed Electronic Specialty Co. sales representative in Pennsylvania, Washington, D.C., West Virginia, Virginia, Maryland, Delaware, North Carolina and southern New Jersey. The firm will handle switching components manufactured by ES's Electronics Divisions in Los Angeles and in Portland, Ore. These include time delay relays, general purpose relays and coaxial switches. . . . *Spaco, Inc., Huntsville, Ala., has been named authorized service depot for Fairchild-Du Mont oscilloscopes, pulse generators, oscilloscope cameras and other measuring instruments and accessories. Facilities of Spaco are located in the Huntsville Industrial Center.* . . . Motorola Semiconductor Products, Inc., Phoenix, has relocated two district sales offices. The office formerly located in Buena Park, Calif., has been moved to Fullerton. New Cleveland address for the sales office is 6459 SOM Center Rd.

International

Ampex Corp. Redwood City, Calif., will occupy leased facilities in 1964 near Brussels, Belgium, and open its own new $600,000 building in the same area in early 1965. Ampex plans to manufacture instrumentation and computer tape recording equipment in Belgium for Common Market customers. Ampex will also spend about $1 million on a new plant to expand facilities at Reading, England. Scheduled for completion about October, 1964, the plant will be used for manufacturing magnetic recording and ferrite memory devices. . . . *Aerojet-General Corp. and The Bristol Aeroplane Co. of Canada have jointly opened a $2-million Canadian Bristol Aerojet, Ltd., plant near Winnipeg, Manitoba. The facility will produce solid propellant motors for Canada's Black Brant rocket.*

Unit Promises Laser Output Control

AN INTERFEROMETRIC module, recently developed by Electro-Optical Systems, Inc., could provide the solution to precise control of laser output radiation. The unique optical circuitry, developers claim, can be employed for dividing or attenuating a laser output in either the visible or infrared portion of the spectrum.

The module, originating from work performed by the company's Quantum Physics Div. for the Air Force's Rome Air Development Center, could well become a key element to practical use of coherent light energy in communications or surveillance systems, particularly where exact phase-coherence control is needed.

With the EOS unit, laser-beam phase shifting, power division and attenuation can be performed without mechanical movement. This design, developers point out, obviates the danger of over-sensitivity to manual control. Also, it permits more rugged, compact construction.

To achieve this end, two gas-cell phase shifters are used that are capable of shifting output beam phases over a 360-degree range. Each is located between a 50-50 frustrated total-reflectance beam splitter and a totally reflecting mirror to form a rectangular configuration with the reflecting surfaces at diagonally opposite corners.

Coherent, plane-polarized beams from a ruby crystal laser and helium-neon gas laser, with outputs at approximately 0.7 microns and 0.6 microns respectively, were used by EOS scientists in laboratory tests. They stresse that other laser sources can be used

In operation, the laser beam is aime into the rectangular interferometri module where it is divided by the firs beam splitter (see diagram). Half o the split beam is then fed directl through a gas-cell phase shifter onto totally reflecting mirror where it undergoes a 90-degree directional change an continues into the output beam splitter

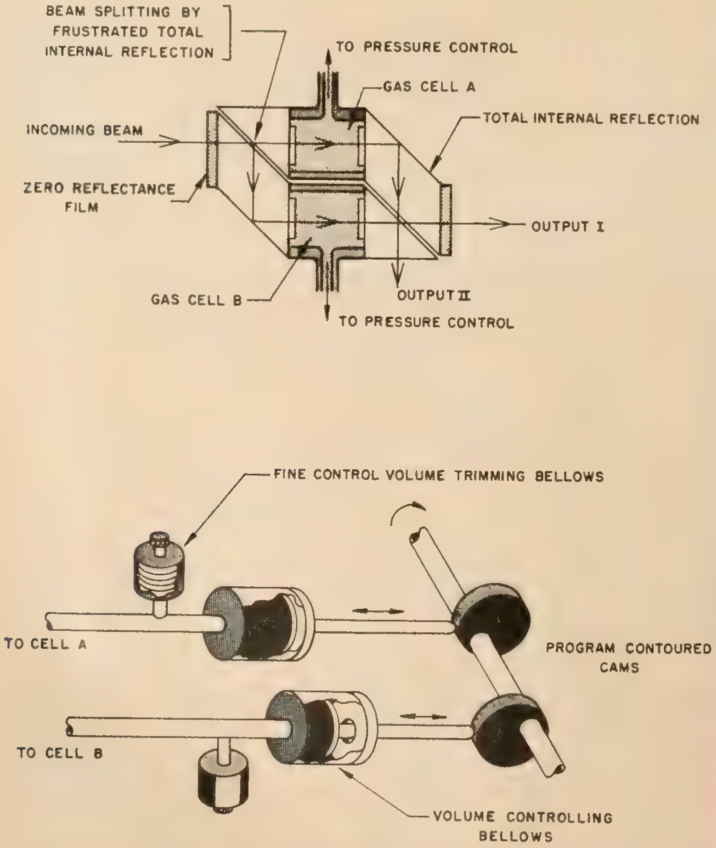
The second half of the beam travel a similar circuit path but in differen sequence. It is first reflected 90 degree by the input splitter, turned another 9 degrees by a second totally reflectin mirror, passed through a second gas cell phase shifter and then aimed int the output splitter.

By equal and opposite control o gas pressure in the phase shifters, eac output can be varied in amplitude rati from zero to —30 db without phas change. The power divider can also b used as an attenuator by employmen of only one output arm.

Simultaneous tuning of the tw phase shifters is accomplished by pressure control bellows system, whic is driven by a non-linear programme cam. This allows the advancement o the phase beam by a specific amoun while the phase of the second beam i retarded equally. The selection of ga for the phase shifter is dependent upo the wavelength range desired.

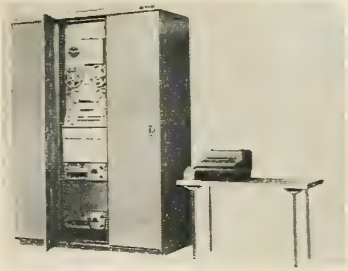
Power losses due to surface reflections have been minimized in the system by anti-reflection coatings. Bot these coatings and the frustrated tota reflectance splitters must be fabricate for the particular wavelength region fo which they are to be used. ∎

Circle No. 225 on Subscriber Service Card



EOS INTERFEROMETRIC Module: TO —A three-dimensional configuration woul use gas-cell phase shifters located betwee beam splitter and mirror. Reflecting su faces of rectangular structure thus forme are located at diagonally opposite corner BOTTOM—A bellows system and no linear programmed cam drive is employe to control phase shifter gas pressure.

New Product of the Week: Digital Events Evaluator



Scientific Data Systems, Inc., is marketing the Model DEE-3 digital events evaluator, which scans up to 768 digital input lines every four milliseconds.

The unit is organized around a standard general purpose digital computer, and can handle a variety of data-reduction and data-correlation problems without hardware change. Printout may be done by an input/output typewriter or paper tape punch. A line printer and magnetic tape unit are optional.

The device exceeds requirements of MIL specifications, including MIL-I-6181D for radio frequency interference. Nominal inputs are 0 and 24v. Tolerances are from 0 to 3v for a "0" signal and above 8v for a "1" signal.

Circle No. 229 on Subscriber Service Card

Power Transistors

Semiconductor Products Div. of Motorola, Inc., has developed a TO-3 ackaged silicon PNP power transistor eries, suitable for high-current switchig and amplifier applications.

Designated 2N3021 through N3026, the units are said to be an rder of magnitude faster than comarable devices. Specified rise time is 00 nsec. (maximum) at currents up o 1 ampere.

In amplifier applications, the units ave a frequency range of 2 to 30 megaycles with power outputs from 1.5 to 0 watts.

Circle No. 226 on Subscriber Service Card

Voltage/Frequency Source

Wilk Instruments is marketing the Model M-2 integrated voltage/freuency source.

The device provides voltage selecon from 0 to 1,500v and frequencies etween 20 and 100,000 cps. Amplitude nd line stability exceeds 0.05%. Waveorm distortion is less than 0.1%.

The unit offers 11 maximum ranges nd is available for rack mounting or in cabinet for bench use.

Circle No. 227 on Subscriber Service Card

Pulsed Ruby Laser

Maser Optics, Inc., is marketing the Model 3300 pulsed ruby laser with a uaranteed output of 500 joules.

The unit, which may be of flat or TIR-type fabrication, is capable of firing better than once every 5 min. The ruby od is 0.04 to 0.05% chromium doped nd measures 7 x ⅝ in. The laser has a iquid nitrogen cooling system with an utomatic level controller.

Q-switching devices provide an output of greater than 60 megawatts in approximately 40 nanoseconds.

Circle No. 228 on Subscriber Service Card

Clad Strip Line Material

A clad strip-transmission line mateial with low-loss characteristics at microwave frequencies has been developed by Electronized Chemicals Corp.

Called Polyguide, the clad dielectric s made of irradiated polyolefin. Overall thickness variation is better than ±0.002 in. Dielectric constant is 2.328 with a total variation of ±0.005 maximum at 1,300 mc. Loss factor is 1.2 x 10^{-5} at 1 mc. Attenuation of a 50-ohm line is 0.14 db/ft. at 1,300 mc.

Polyguide is available in standard size sheets of 24 x 36 in., and in thicknesses of ⅛ or 1/16 in. Peel strength is 4½ lbs. per in. width at 72°F. No adhesives are used in the lamination process.

Circle No. 230 on Subscriber Service Card

Delay Module

The Unity Gain Delay Module, providing delays to 2,000 μsec. at standard logic levels, is available from Deltime, Inc., of the Sealectro Corp.

The unit operates in a return-to-zero mode and has an output pulse of —6.6-v amplitude and 0.50-μsec. width. Input requirements are —6.6 amplitude, 0.50-μsec. width, with rise and fall times of 0.08 μsec. Maximum pulse repetition frequency is 1 mc.

Circle No. 231 on Subscriber Service Card

Static Inverter

A radiation-hardened 250 VA solid-state static inverter has been developed by Data & Controls Div., Lear Siegler, Inc.

The Model SIS-3-420081-RH is a three-phase, all silicon unit designed to withstand shock and vibrations up to 40 g's at temperatures from —30 to 165°F. Under tests, the device has withstood radiation levels of 6 x 10^{13} fast neutrons/cm^2 total dosage.

The unit has an input of 22 to 29.25v dc and produces 400 cps, 115v ac. Voltage and frequency regulation is ±0.002%.

Circle No. 232 on Subscriber Service Card

Vibration Transducer

The Type 4-125 vibration transducer, which will operate continuously at 700°F, has been developed by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

The device is calibrated for use with any a-c voltage-measuring unit which presents a 10,000-ohm resistive load impedance to the transmitter. Temperature range is —65 to 700°F. Sensitivity is 105 millivolts/in./sec. over a frequency range of 45 to 1,500 cps. Amplitude range is 0.1 in. peak-to-peak maximum. Acceleration is 1 to 50 g peak.

Circle No. 233 on Subscriber Service Card

Power Supplies

Servomechanisms/Inc. has developed a line of solid-state power supplies. Multiple dc voltages are available in ranges up to 10 kv with regulation of 0.25% line and load. Ripple is 0.5% peak-to-peak with 73% efficiency.

Volume of a nine-output unit is 28 cu. in. and 2.5 lbs.

Circle No. 234 on Subscriber Service Card

Thin-film DC Amplifier

Halex, Inc., has available the Model 1030, a general purpose thin-film dc amplifier. The device has preset gain up to 100, bandwidth of 100 kc. and drift of less than 100µv/°C. Thickness of the module is 0.1 in.

Output amplitude into a 1K load is one-volt RMS at an output impedance of less than 100 ohms. Power requirement is ±12v. Operating temperature ranges from −40° to 100°C.

Circle No. 235 on Subscriber Service Card

Traveling Wave Tube

Microwave Associates, Inc., is marketing the MA-2002A, a high powered communications traveling wave tube, designed for long-haul relay systems, particularly for unmanned stations.

The unit provides 15 watts of RF power over a range of 5.9 to 6.4 gc. Normal communications performance is obtained at 7.5 watts output with a 34-db gain.

Circle No. 236 on Subscriber Service Card

Power Source

Microwave Associates, Inc., has available the MA-8168, a high-power solid-state source for crystal-controlled transmitter driver applications in the 12.4 to 14.0-gc range.

Minimum power output is 100 milliwatts at a specified frequency. Harmonics are suppressed by −40 db below output signal. Crystal control stability is ± one part 10^6 long term per day. Short-term stability is one part 10^9 per millisecond. Operational life is 10,000 minimum.

Input power requirements are 28v dc at 300 milliamp and 48v dc at 600 milliamp for the oscillator amplifier stages. Crystal oven operates from 28v at 6 w, with a 20-sec. on/off cycle.

Circle No. 237 on Subscriber Service Card

DC/FM Transducer

An industrial dc/FM pressure transducer is being marketed by Wiancko Engineering.

The device can be mounted on post or parapet at the source to be monitored or rack-mounted for single channel or multi-channel systems.

Pressure and ranges available include: 0 to 1 to 0 to 5,000 psig; 0 to 1 to 0 to 5,000 psid; and 0 to 15 to 0 to 3,000 psia. Overall accuracy is ±0.15% for 0 to 2,500 psi and ±0.25% for 2,500 to 5,000 psi. Power requirement is 24 to 28v dc at 40 ma regulated. Output impedance is approximately 100 ohms.

Circle No. 238 on Subscriber Service Card

DC Volt/Ammeter

Ballantine Laboratories has available the Model 365 dc volt/ammeter.

The device has a voltage range of 1 mv to 1,000v; current range is 0.001 microamps to 1 amp. As a dc amplifier, the unit has a 100-db gain with output of 0.1 to 1.0v dc for each range selector step.

The device has a single 5-in. logarithmic scale and a built-in calibrator

Circle No. 239 on Subscriber Service Card

Miniature Capacitors

A line of subminiature straight-wal tantalum capacitors with liquid electrolyte seals is being marketed by th Capacitor Dept. of International Telephone & Telegraph Corp.

The insulated device features 85°C capability. The electrolyte is thixotropic

The line includes four case size ranging from 0.3 in. long and 0.1 i diameter to 0.9 in. long by 0.2 in. i diameter. There are 28 standard unit with capacitances between 2 and 33 microfarads. Working voltages rang from 6 to 60v.

Circle No. 240 on Subscriber Service Card

Circuit Checker

Computer Div. of Packard Bel Electronics is marketing the MBK breadboard and training kit for development and checkout of digital circuits.

The device consists of an indicato panel, signal generator, power suppl and module sections and adapters. U to 18 digital circuit modules can be connected and operated simultaneously wit the breadboard kit; sections holding si modules each can be added.

Signal generator controls provid clock signals in 11 steps from 1 pps t 5 mc with a control for single cloc pulses. Power supply has −12v and 6 outputs.

Circle No. 241 on Subscriber Service Card

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Circle No. 16 on Subscriber Service Card

Signal Source

Wavetek is marketing the Model 102 Signal Source, offering three wave outputs in a frequency range from 0.008 cycles to 1 megacycle.

The device provides sine or triangle, and square waves from three simultaneous outputs: 5v sine/triangle wave, low impedance; 10v square wave, 600 ohm impedance; and 1v square wave, 500 ohm impedance. Frequency response is 0.1 db to 100 kc and 1 db to 1 mc.

Sine wave distortion is less than 1% to 10 kc and less than 2% to 100 kc. Rise and fall time for 50 ohm square wave output is 5 nanosecond and for 600 ohm output is 15 nanosecond.

Circle No. 242 on Subscriber Service Card

Spectrum Analyzer

Raytheon Co.'s Industrial Components Div. is marketing the Model MRFR 150-2 spectrum analyzer with an operational range of 3 cps to 13 kcs.

The device uses 50 parallel filter channels spaced 2 cps apart to provide resolution of 5 cps in a 100-cps range. Another 100 channels spaced 10 cps apart offer 25 cps resolution over a 1-kc range.

RC time constants for channels are from 0.1 to 100 seconds. Outputs are sampled at one or more rates from 1 to 3,000 per second.

Circle No. 243 on Subscriber Service Card

Coaxial Circulators

E&M Laboratories has developed a line of broadband circulators that cover up to 35% bandwidths in the UHF range of 250 to 1,000 mc.

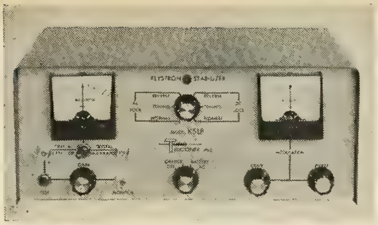
The Model U120LYC operates in the 375 to 550-mc range with isolation of 20 db minimum, insertion loss of 0.5 db maximum and a VSWR of 1.25 maximum.

The Model U121LYC has a range of 500 to 650 mc and a minimum isolation of 20 db. Insertion loss is 0.5 db maximum. VSWR is 1.25.

Model U122LYC covers a range of 700 to 1,000 mc with 17 db minimum isolation. Maximum insertion loss is 0.5 db, and maximum VSWR is 1.30.

Circle No. 244 on Subscriber Service Card

Klystron Stabilizer



Triconix, Inc., has developed the Klystron Stabilizer Model KSLP, which provides closed loop locking of klystron oscillator frequency to an external cavity.

Stabilization may be obtained either in the reflector FM mode (AC lock) or the Pound mode (DC lock). Bandwidth of 1,000 cps permits suppression of 60 cycle hum components. The unit has a 40-v correction range and 3,500v insulation. Gain is 120 db.

Circle No. 245 on Subscriber Service Card

Decade Generator

The Type 308G two-phase signal decade generator is being marketed by Ad-Yu Electronics, Inc. The instrument operates on the basis of the R-C phase-shift principle.

The device provides two simultaneous outputs, 90° phase difference from 0.1 to 1,000 cps. Accuracy is ±2%. Frequency stability is within 0.2%; frequency control is four decades, and distortion is less than 1.5%.

Output amplitude is adjustable from zero to 5.5v RMS. Source impedance is 20 ohms maximum. Input power is 115v ±10%, 50 to 60 cps, approximately 100 va.

Circle No. 246 on Subscriber Service Card

Electronic Tachometer

Airpax Electronics, Inc., has available the Type N Tach-Pak, an electronic tachometer with output signals from 1 to 5, 4 to 20, or 10 to 50 ma dc.

The device has an input signal of 0.25 to 5v RMS. Resistance is 600 ohms nominal. Any input frequency can be provided. Linearity is 0.25% or better. Output ripple is less than 0.5% RMS of full scale at 120 cps.

The unit requires a power supply of 115 ±10v RMS, 60 cps, 5 watts nominal. Operating temperature is —10° to 125°F.

Circle No. 247 on Subscriber Service Card

DC/DC Converter

Tele-Dynamics Div. of American Bosch Arma Corp. has developed a solid-state dc/dc converter that provides a 250-v B+ power supply for tube telemetry transmitters.

The device has a 28-v dc input and an output of 30 watts at 250 ±5v dc. Maximum ripple is 1.0v RMS.

The circuit consists of a multivibrator power oscillator driving a step-up transformer. Output is rectified and filtered to provide the required level and current capacity.

Circle No. 248 on Subscriber Service Card

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SPACE AND INFORMATION SYSTEMS DIVISION
NORTH AMERICAN AVIATION

Variable Capacitors

TRW Semiconductors, Inc., is marketing a line of 26 voltage variable capacitors, the PMV Micro High Q Varicap.

In a capacitance range of 1 to 47 pf, the devices have Q values from 50 to 200 at −4v at 50 mc. Maximum working voltages exceed 100v. Power dissipation is 250 mw. Cut-off frequencies exceed 30 g.

The units have a 0.06-in maximum diameter and a 0.13-in maximum length.

Circle No. 249 on Subscriber Service Card

Multiplexer

A solid-state multiplexer, the Model 2000S, is being marketed by Gulton Industries, Inc.

The device accepts low-level and high-level multiple analog inputs, operating differentially or single-endedly. Standard production provides 30 differential or 60 single-ended analog inputs. With modification, the number of inputs can be doubled.

Power consumption is 525 milliwatts. Input voltage is 10mv to 30v F.S. Accuracy is ±0.1% or greater.

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Servoamplifier

Boonshaft and Fuchs, Inc., is marketing the Model 571 Servoamplifier with a drift of less than 20 µv per day and 5 µv per degree C.

The solid-state unit has a gain of 10^7 at dc, an input impedance of greater than 1 megohm and output up to ±50v at 3 watts. Load-carrying capability is greater than 0.1 mfd.

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Differential Multiplexers

Scientific Data Systems, Inc., has developed a line of differential multiplexers with an input voltage range from ±1 to ±100v.

From 16 to 128 channels or a combination of differential and single-ended inputs, can be provided in a single unit. Output is 0.01% of final value within a nominal 20 microsec after selection. Operation is reliable up to 100°C.

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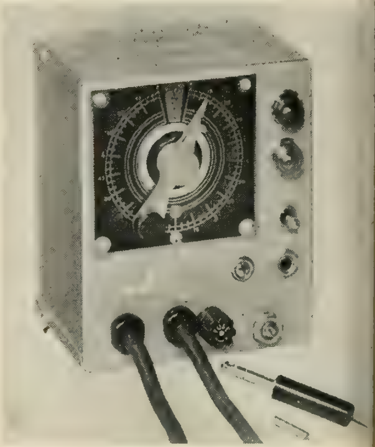
Digital Voltmeter

The Model SV3 Statistical Voltmeter has been developed by Non-Linear Systems, Inc.



The unit has a 19-class display, each class represented by a bar of light with an adjustable width. Up to 100 samples can be entered for each class; additional auxiliary flipflops and control logic can increase this number to 200/ class. Accuracy is ±0.01% and speed is 5 entries per sec.

The unit measures dc voltage up to ±999.9v. Front panel 4-digit control allows, midpoint setting plus range and polarity within the ranges of ±9.999/ 99.99/999.9v.

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Cooling Module

A three-stage thermoelectric cooling module, the Model 417-4-1, is being marketed by Jepson Thermoelectrics Inc.

The solid-state device can maintain −90°C or better with a hot side a 27°C. Thermal derating is 0.035°C pe milliwatt for heat loads up to 200 milliwatts. Maximum power input is 1 watts.

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Reflex Klystron

A reflex klystron, tunable from 8. to 12.4 gc, is being marketed by th Electronic Tube Div., Westinghous Electric Corp.

The Model WL-128 has a minimu power output of 100 milliwatts. Nominal power output is 150 milliwatts Nominal beam voltage is 500v; maximum is 550v.

The unit can be tuned without us of tools. Rate is approximately 1,00 megacycles per turn of a single tunin screw. Mated with a tuning adapter, th rate is 60 megacycles per turn.

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contracts

AIR FORCE

13,701,176—**Hercules Powder Co.,** Magna, Utah, for further production of third stage motors for the *Minuteman* missile.

27,200,000—**Boeing Co.,** Seattle, for continuation of *Dyna-Soar* development.

15,530,895—**Avco Corp., Research and Advanced Development Div.,** Wilmington, Mass., for a low observable re-entry vehicle (LORV) including design, development and flight testing.

,000,000—**General Dynamics Corp., Astronautics Div.,** San Diego, for continued work on an advanced re-entry vehicle for the *Atlas* ICBM.

,500,000—**Thiokol Chemical Corp.,** Bristol, Pa., for continued development and related work on the propulsion system for the first stage *Minuteman* ICBM.

,200,000—**Raytheon Co.,** Santa Barbara, Calif., for production of special electronics equipment.

,000,000—**General Telephone and Electronics Corp.,** Waltham, Mass., for incremental funding for a cable communications system to link *Minuteman* ICBM sites.

,400,000—**Radio Corp. of America,** Moorestown, N.J., for development work on electronics equipment associated with an early warning radar system.

,400,000—**Hughes Aircraft Co.,** Los Angeles, for a digital communications system.

,900,000—**Hercules Powder Co.,** Magna, Utah, for further research and development on third stage engines for the *Minuteman* ICBM.

,800,000—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for maintenance and repair of control and guidance equipment for the *Minuteman* ICBM.

,600,000—**International Telephone and Telegraph Corp.,** Fort Wayne, Ind., for continuation of work on an operations control center.

,500,000—**Philco Corp., Western Development Laboratories Div.,** Palo Alto, Calif., for continued development of a satellite control system.

,400,000—**General Electric Co., Missiles and Space Vehicles Div.,** Philadelphia, for continued research and development on radar beacons designed to equip target vehicles.

,400,000—**North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for production of modification kits and spare parts for the *Hound Dog* missile.

,000,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for production of ground electronic system components for the *Minuteman* ICBM.

80,000—**Aerojet-General Corp.,** Sacramento, Calif., for items for depot tooling, maintenance, etc., for work on the *Titan I* and *Titan II* propulsion systems.

ARMY

9,000,000—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for further research and development on the *Shillelagh* anti-tank missile.

,500,000—**Western Electric Co.,** Whippany, N.Y., for further research and development on anti-missile capabilities being developed in the *Nike-Hercules* ground-to-air missile.

NAVY

3,000,000—**Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for production of *Polaris A3* missiles.

2,675,851—**Vitro Corp. of America, Vitro Laboratories Div.,** Silver Spring, Md., for engineering services on the *Polaris* fleet ballistic missile weapon system.

,900,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued work on *Polaris* missiles.

,700,000—**United States Steel Corp.,** Washington, D.C., for MK 40 warheads.

374,979—**Sylvania Electric Products, Inc.,** Needham, Mass., for development of a research tool designed to study anti-submarine warfare programs.

700,000—**Bendix Corp.,** Mishawaka, Ind., division, for pre-test preparation of missiles.

584,726—**General Electric Co.,** Washington, D.C., for increased effort for operational support of *Polaris* fire control guidance support equipment.

NASA

,700,000—**Aerojet-General Corp.,** Azusa, Calif., for continued design work on a liquid hydrogen/LOX rocket engine for the Lewis Research Center.

,400,000—**TRW Space Technology Laboratories,** Redondo Beach, Calif., for various space equipment projects.

900,000—**General Electric Co., Missiles & Space Vehicles Div.,** Philadelphia, for development of operational procedures, field support and initial management of the *Nimbus* satellite data-handling system.

INDUSTRY

,700,000—**Fairchild Stratos Corp., Space Systems Div.,** Rockville, Md., from **Martin-Denver,** for a standard payload fairing to be used to protect various payloads atop the *Titan III* booster system.

313,000—**Systron-Donner Corp., Systron Div.,** Concord, Calif., from **Emerson Electric Corp.,** for several key components of the large general-purpose automatic test system (GPATS).

177,615—**Giannini Controls Corp., Powertron Corp. Division,** Plainview, N.Y., from **Martin-Denver,** for ultrasonic propellant gaging sensors for the *Titan III* space launch vehicle.

133,000—**General Precision, Inc., Kearfott Div.,** Little Falls, N.J., from **Hughes Aircraft Co.,** for a gyro concept for incorporation into the antenna reference gyro (ARG) of the *Phoenix* missile being designed for use by the TFX aircraft.

100,000—**RdF Corp.,** Hudson, N.H., from **Martin-Denver,** for design, development and manufacture of convective heat and thermal radiation transducers.

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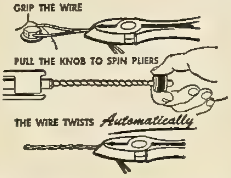

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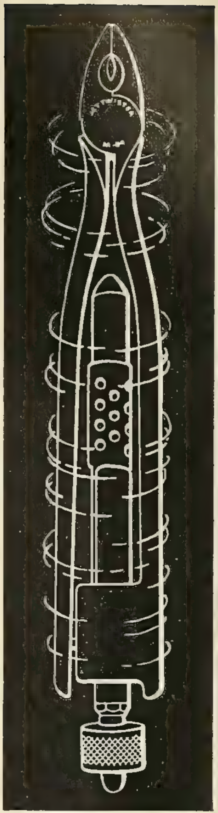

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names in the news

James J. Ling: Elected chairman of the board of Ling-Temco-Vought, Inc., Dallas. Remains chief executive officer of the company. Succeeds **Robert McCulloch,** who remains chairman of the executive committee.

Fred J. Borch: Elected president and chief executive officer of General Electric Co., New York City. **Gerald L. Phillippe** elected chairman of the board.

David W. Lang: Joined the Nortronics Div. of Northrop Corp., Anaheim, Calif., as executive advisor for special projects in the Systems Support Dept.

Walter Morton: Appointed technical director of Dynamics Instrumentation Co., Monterey Park, Calif.

Cecil F. Shelton: Named eastern regional sales director of Data Products Corp., Washington, D.C.

John H. Quinn, Jr.: Named manager of the structures and aerophysics department at the Martin Co.'s Denver Div.

Ralph B. Reade: Appointed director of sales and business development for the Military Products Div. of Hoffman Electronics Corp., Los Angeles.

James E. Coppage: Rejoined Giannini Controls Corp.'s Cramer Div., Old Saybrook, Conn., as marketing manager.

Ellis E. Lapin: Promoted to director of program 206 in the Engineering Div. of Aerospace Corp.'s El Segundo, Calif., Technical Operations. **Dr. Charles W. Sarture** named director of the sensing and information sciences subdivision of the Systems Research and Planning Div. **Pat Maxwell, Jr.,** named head of the systems effectiveness section of the operations analysis department. **Edwin A. Goldberg** named director of the standardized space guidance program office. **Howard F. Marx** named assistant director of the 706 study program office.

Robert J. Wilson: Appointed district representative for the Romec facility of Lear Siegler's Power Equipment Div., Elyria, Ohio, covering the Eastern New York and Northern New Jersey areas.

Dr. John L. Grigsby: Elected vice president-engineering of Applied Technology, Inc., Palo Alto, Calif.

Dr. Lester M. Field: Approved vice president-research of Hughes Aircraft Co., Culver City, Calif.

George G. Congdon: Named manager of test and launch operations for the *Atlas* weapon systems at General Dynamics/Astronautics, San Diego.

Arvid S. Peterson: Promoted to controller and director of finance at TRW Space Technology Laboratories, Space Park, Redondo, Beach, Calif. **C. R. Walker** appointed manager of the newly created Proposal Development Dept.

Allen H. Orbuch: Promoted to vice president-marketing of the Guidance and Control Systems Div. of Litton Industries, Beverly Hills, Calif.

Richard J. Heimer: Appointed chief optical designer at Fairchild Space and Defense Systems, Syosset, N.Y.

William K. Kindle: Named new product program manager for Electronic Associates, Inc., Long Branch, N.J.

Carroll D. Atwood: Joined the Singer Co., Metrics Div., as director of industrial relations for the electronic and electrical instrumentation division, Bridgeport, Conn.

Edward J. Bacon: Promoted to research director at Booz, Allen Applied Research, Inc., Washington, D.C.

James M. Beggs: Named general manager of Westinghouse Electric Corp.'s electronics division, Baltimore.

Milton J. Berg: Appointed assistant director of the Engineering Mechanics Laboratory of TRW's Space Technology Laboratories, Inc., Redondo Beach, Calif.

Edwin A. Cavanagh: Appointed director of sales at Cannon Electric Co., Los Angeles.

Ray Cutler: Appointed manager of sales engineering at Eldon Fiberglass Manufacturing Co., Compton, Calif.

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NOVEMBER

AIAA Vehicle Design and Propulsion Conference, Air Force Systems Command, Wright-Patterson Air Force Base, Dayton, Ohio, Nov. 4-6 (classified).

IEEE Northeast Electronics Research and Engineering Meeting (NEREM), Commonwealth Armory/Somerset Hotel, Boston, Nov. 4-6.

Society for Experimental Stress Analysis Annual Meeting and Exposition, Statler Hilton Hotel, Boston, Nov. 6-8.

ADME/AIAA/SAE/ASQC Joint Technical Conference, Disneyland Hotel, Anaheim, Calif., Nov. 7-8.

Magnetism and Magnetic Materials Conference, sponsored by AIEE, IRE and AIP, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., Nov. 11-15.

Seventh Annual NMR-EPR Workshop, sponsored by Varian Associates, Palo Alto, Calif., Nov. 11-15.

Fall Joint Computer Conference, sponsored by IRE, AIEE, Association for Computing Machinery and American Federation of Information Processing Societies, Las Vegas Convention Center, Las Vegas, Nev., Nov. 12-14.

Seminar on Automatic Checkout Equipment and Techniques, sponsored by NASA's George C. Marshall Space Flight Center and Battelle Memorial Institute, Columbus, Ohio, Nov. 13-14.

American Society of Mechanical Engineers Winter Annual Meeting, Bellevue-Stratford Hotel, Philadelphia, Nov., 17-22.

Engineering in Medicine and Biology Conference, sponsored by AIEE, IRE and ISA, Lord Baltimore Hotel, Baltimore, Nov. 18-20.

Sixth National Symposium, Society of Aerospace Material & Process Engineers, Olympic Hotel, Seattle, Nov. 18-20.

MAECON Symposium on Measurement and Instrumentation, sponsored by IEEE, Hotel Continental, Kansas City, Mo., Nov. 21.

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The Brake and the Throttle

NEVER HAS THE VULNERABILITY of the U.S. manned lunar landing program been more clearly demonstrated than by the confusion—it might almost be described as panic—which followed Nikita Khrushchev's statement in Moscow on the Soviet lunar project.

The daily press in general, and the two big wire services in particular, must bear a strong responsibility for the misinterpretation which touched off the shambles.

The lead of the United Press International story from Moscow stated:

MOSCOW, Oct. 26—(UPI)—Premier Nikita Khrushchev withdrew from the Moon race tonight. He wished the Americans "success."

The Associated Press lead was only slightly more qualified:

MOSCOW, Oct. 26—(AP)—Premier Khrushchev said today the Soviet Union is not, at present, in the race to be first with a man on the Moon and wished the United States good luck in its attempt to do it by 1970.

The *Washington Post* on Sunday noted "Khrushchev's withdrawal from the Moon race," the *New York Times* on Monday discussed "Premier Khrushchev's statement that (the Soviet Union) does not choose to race to the Moon," and the *Wall Street Journal* on Tuesday took up "Russia's readiness to formally cede the Moon race without a struggle."

Mr. Khrushchev, in fact, had said none of this. In response to a question as to whether a Soviet manned lunar flight was planned for the not-too-distant future, he had replied: "We are not at present planning flights by cosmonauts to the Moon." He went on to say that Soviet scientists are working on the problem and that the necessary research is being done, a statement which cooler heads have noted is confirmation by the Soviet premier of a continuing Rusisan manned lunar project.

Mr. Khrushchev also said: "We do not want to compete with the sending of people to the Moon *without careful preparation*," a qualifiation almost entirely lost in the ensuing clamor. The full text of the Soviet premier's statement is on p. 14. It should be read carefully. Nothing in it commits the Soviet Union to a withdrawal from the lunar race. Just the opposite, it is confirmation at the highest official level of the existence of a Soviet lunar project. The meaning of Mr. Khrushchev's statement that the Russians are not planning such flights "at present" is clear enough in the context of the question asking whether such a flight could be expected in the not-too-distant future. A U.S. spokesman could make the same reply to the same question.

But the entire blame for the chaotic reaction to such a simple statement does not rest on the press. Administration and Congressional leaders did more than their share to lend credence to the belief that Mr. Khrushchev has only to whistle in order to have the U.S. dance to his tune.

Perhaps the most astounding reaction of all came from NASA Administrator James Webb, who was quoted as saying that in light of the Khrushchev statement, the NASA program "is going to have to be weighed very carefully now." He added: "As I have said before, our Moon project is like a machine which has a brake as well as a throttle." This statement came on the day the wire stories from Moscow appeared. Had the stories been correct, it would have been an amazing confession that Mr. Khrushchev was calling the tune on the U.S. space program. Under the circumstances, it was little short of incredible and it tore down months of a carefully built case for Congressional support of the NASA budget.

There was the usual yammering from those in Congress who lust after the NASA money for pet projects of their own, and even the usually astute Sen. Clinton Anderson, who heads the Senate space committee, was moved to remark, "It may be that the pace of the lunar project now can be a little more leisurely."

Executive Secretary Edward Welsh of the National Aeronautics and Space Council regained some ground for the Administration. He not only cautioned against interpreting Khrushchev's remarks as being a lessening of the Soviet effort but warned: "They have sensed some slackening of support for the Moon program here and have made a strategic move to capitalize on this situation."

THE IRONY of the whole fiasco is that it may have had some value in demonstrating on what shaky footing the U.S. lunar program rests. As we have said before, the industry has not done a good job of selling the U.S. public on the aims and goals of the national space program. Nor has NASA. Too much emphasis has been placed solely on the race with the Russians without explanation of the reasons behind that competition.

Let us be clear. Achievement of the first lunar landing is a worthwhile goal in itself as a propaganda triumph. One need only remember the worldwide reaction to *Sputnik I* to realize what a triumph the initial lunar landing will be. But what an Alice-in-Wonderland aspect this race has taken on in these last few days. It apparently is proposed we should be in it only if we will finish second. Seemingly sane statesmen are suggesting that if we seem to be winning, or if our opponent quits, then we should abandon the race. Curiouser and curiouser.

But achievement of the first landing is not the only, or the most important, objective of Project *Apollo*. More important is the development of the science and technology necessary to accomplish the landing. This will guarantee us not only pre-eminence in space but pre-eminence on Earth.

We would like to hear a clear statement from President Kennedy—and only the President can make it—to this effect: "The United States will continue to move ahead with its carefully planned manned lunar program as scheduled, regardless of what the Soviet Union does or does not do. Our program is not a crash program and is not geared to theirs. Let's wish them success—but we intend to be first."

For such a program, no brake is needed.

William J. Coughlin

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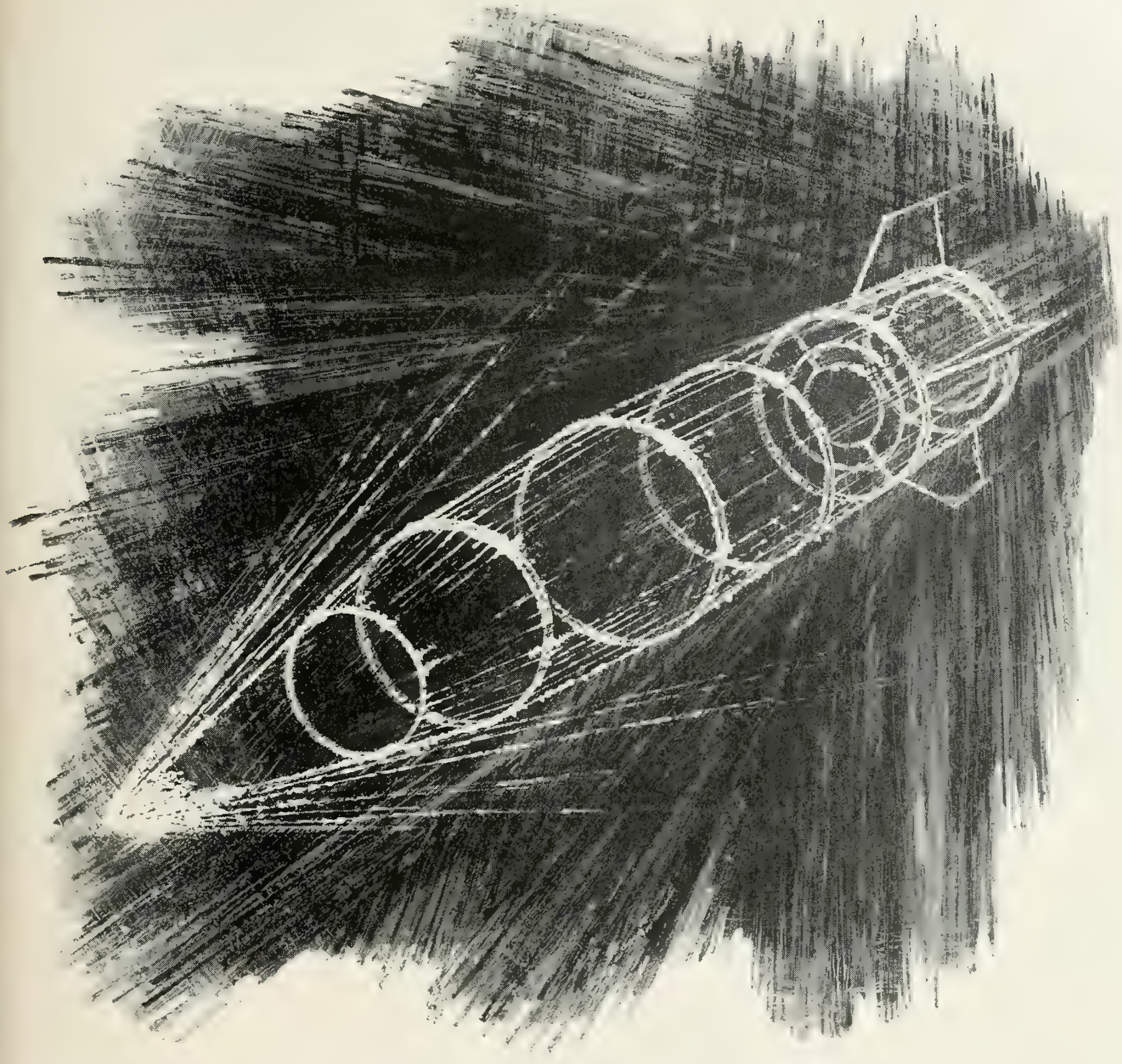

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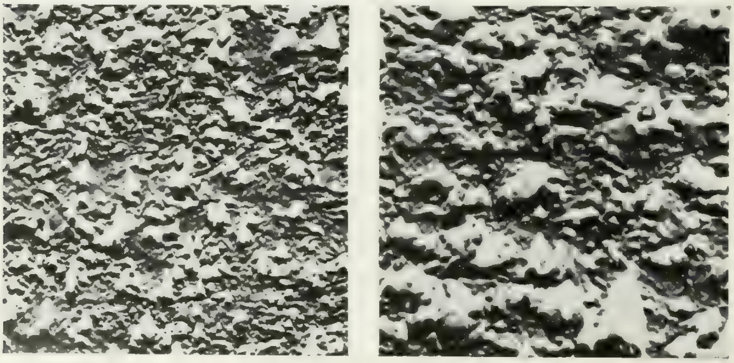
Electron microphotographs of surfaces of Memorex tape and competitive product at the same magnification (6000x).



MEMOREX TAPE

LEADING COMPETITIVE TAPE

Users of Memorex Type 62 Broadband Tapes receive important performance advantages, including:

as much as 6 db more response at the highest frequency—the result of the ultra-smooth surface;

as much as 3 db greater undistorted output — the result of a coating more densely packed with well-oriented particles of oxide;

more than 3 db higher signal-to-noise ratio—the result of extreme uniformity of distribution of particles within the coating;

no measurable increase in dropouts, even after 100 plays — the result of scrupulous cleanliness and care in manufacturing and the use of a durable, electrically conductive coating which will not shed oxide.

These improvements in performance were measured on a Mincom CM 100. Still greater improvements can be expected when using recorders with more extended bandwidth.

Memorex broadband tapes offer you a wider choice of coating thickness to suit your recording application:

62J (370 μinch coating) — for high output

62K (270 μinch coating) — a new intermediate coating thickness

62L (170 μinch coating) — the thinnest coating offered to date, giving you 25% more playing time per roll.

Digital or pulse recording applications — The smooth, thin coatings of Type 62 Broadband Tapes will provide the higher resolution and greater pulse packing densities required by advanced recording systems.

Memorex manufactures precision magnetic tapes for instrumentation and computer use, including Type 22 Computer Tape (tested and certified at 800 and 556 bpi), Type 33 Instrumentation Tape, Type 42 High Resolution Tape, and Type 62 Broadband Tape. To obtain complete technical data sheets, write to Memorex Corporation:

1184 Shulman Avenue / Santa Clara, Calif

Important New Report for all Instrumentation Tape Users

MEMOREX Monograph #2, titled "*Head Wear Considerations in Magnetic Tape Recording*," available free on request. Write MEMOREX at address above.

MEMOREX MONOGRAPH NO. 2

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PRECISION MAGNETIC TAPE

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Engineers/Scientists...like to share in the Genesis of significant new computer techniques?

...like Magnetic Logic for an Astronaut

Conceiving and developing novel and advanced computer techniques and systems is standard procedure at Burroughs Laboratories.

The midget computer—D210—(briefly described to the right)—is one recent example. Another is Burroughs' new, large scale command/control multi-module processing system—D825. This carries on parallel computation, controlled by automatic programming and is, in fact, the first totally modular processor.

Engineers at the Laboratories find our friendly, informal atmosphere conducive to creative work of this calibre. Here a man is associated with cooperating groups but, at the same time, finds management doors always open for the discussion of original ideas.

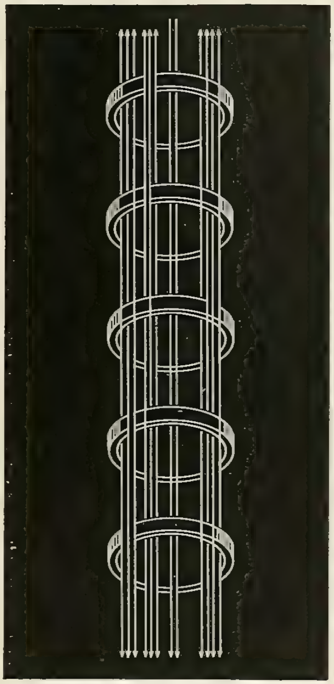
THERE ARE OPPORTUNITIES TODAY ACROSS THE SPECTRUM OF COMPUTER TECHNOLOGY

SOME IMMEDIATE OPENINGS:

Assignments Requiring Deep Experience (7-10 Years) and BS or Advanced Degree.

Command & Control Systems—Create and apply state-of-the-art data processing techniques to c/c systems using nuclear instrumentation. Also opportunities to apply to c/c systems latest techniques in radar, intelligence gathering, missile & space vehicles, communications.

Analysis-Advanced Computer Systems—Preliminary design of computing equipment for use with advanced systems concepts.



Logic in this computer is physically implemented with a device resembling the core-rope fixed memory but distinguished from it by certain novel characteristics. Designed for an astronaut's cabin, this magnetic computer fits into a breadbox, weighs only 19 lbs., but can solve guidance and control equations at lift-off, in orbit and at re-entry at minimum 1-kc rate.

Systems Integration—Develop new concepts in this area for application to broad-base c/c system. Minimum 5 years' experience as supervisor or staff consultant.

Assignments Requiring BS and Minimum of 3 Years' Applicable Experience.

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Logic Design—Specification & detailed logic design of special purpose digital data processing systems. (Several levels)

Digital Circuitry—Design and development of solid state circuitry; circuitry for peripheral equipment; ferrite memories.

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Also a Number of Senior and Intermediate Level Openings in the Following Critical Areas:

Electronic Circuit Design; Value Engineering; Evaluation Engineering; Performance Analysis; Environmental Testing; Equipment Test Coordination; Failure Analysis; Electronic Packaging; Specifications; Maintainability & Reliability Engineering (planning & implementation); Quality Assurance; Equipment Integration (resolving interface problems).

Why not find out more about these unusual positions—and the attractive locations of Burroughs' facilities in the famous Philadelphia Main Line suburbs?

Please write in confidence to Burroughs Laboratories,
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Burroughs Corporation

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An Equal Opportunity Employer

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NEW DEEP-SEA AMPLIFIER TRANSMITS 128 TELEPHONE CONVERSATIONS

Our engineers have developed a new amplifier which simultaneously transmits 128 telephone conversations in both directions over a single cable. It is designed to operate without repair or maintenance on the ocean floor for 20 years.

The new amplifier (illustration below) is an important advance in deep-sea communications technology.

To make a single amplifier operate in two directions, it was necessary to provide a precise, complex filter system to separate the signals. Signals traveling in one direction occupy a frequency band from 116 to 512 kc., and those traveling in the other direction, from 652 to 1052 kc.

The gain of each amplifier must accurately compensate for its share of cable loss. The total loss varies over the frequency band and, in a transatlantic system, reaches a maximum of 9000 decibels. Since there is no way to adjust an amplifier on the ocean floor, the performance of each one must be pre-established with extreme precision.

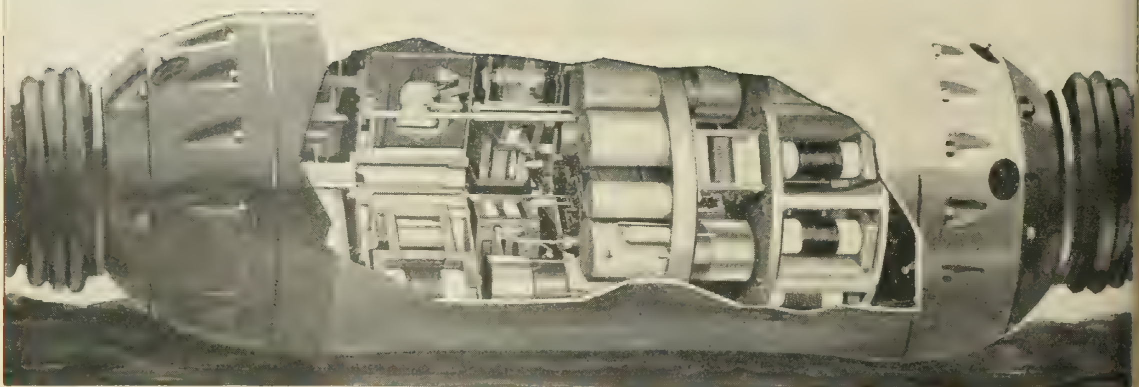
A 3600-mile cable link, with its 180 amplifiers, includes 36,000 electronic components. Each component has to be endowed with a reliability far in excess of the requirements of conventional land systems.

The casing and its seal to the cable must prevent minute water seepage at ocean-bottom pressures. This could accumulate fatally over the years, and so production tests employing radioactive isotopes are used to search for any such microscopic leakage.

In bringing the new underseas system to production, Bell Laboratories worked closely with Western Electric, the manufacturing unit of the Bell System. As always, their prime objective was the reliability which comes from rigidly controlled operations—the kind of reliability that the Bell System is known for in the projects it undertakes for the nation's defense.

BELL TELEPHONE SYSTEM

American Tel. & Tel. Co. / Western Electric Co. / Bell Telephone Laboratories / 21 Operating Companies



These amplifiers are being used in the newest transatlantic cable.

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING Volume 13, Number 20 November 11, 1963

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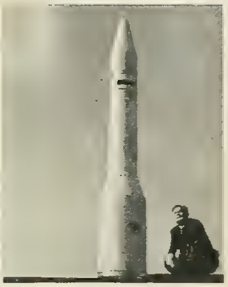

Completed ADDPEP missile, which will carry a high-speed parachute to 100,000 ft. for Mach 2.2 tests, is inspected by F. R. Nebicle, program director for Goodyear Aerospace Corp. The firm is conducting the study of high-speed deceleration and stabilization systems for AFSC's Research & Technology Div. First shot is due this week. See page 28.

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47,250 copies this issue

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If you had to *know why* the stars twinkled...

you'll be interested in a career at Aerospace

Awe-struck, you gazed at the heavens and wondered. *Your* interest went *beyond* merely how many stars there were. *You* had to know what made them twinkle, what keeps them apart, how anyone could *know* how far away they are. If this curiosity has expanded with the years to include astrophysics, celestial mechanics, and trajectory analysis, you may well be the kind of man who'll find an enviable and unique career opportunity at Aerospace Corporation.

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letters

Nuclear Deterrent

To the Editor:

I wonder if anybody has published the megaton equivalent weight of the *Polaris* missile. If you are able to tell me I shall be very grateful.

You will see that the estimates of the British Labour Party vary from half a megaton (986) to 1/16 megaton (1,146). the numbers in brackets being columns in Hansard Vol. 670.

I shall also be very grateful if you can refer me to any number of MISSILES AND ROCKETS which describes nuclear bombs or other nuclear explosive devices of comparatively small actual weight in pounds, i.e. attracted with the force of gravity by less than, say, 500 lbs.

It may amuse you to know that the Labour Party propose to send our troops into action unequipped with nuclear weapons against troops which all probability suggests will be armed with nuclear weapons!

I should very much like to see an appreciation of the value of *Polaris* as a deterrent written by a member of your staff, after reading Hansard Vol. 670 Columns 955-1074 and 1139-1259. This part of Hansard covers the defense debate in Parliament on Jan. 30 and 31, 1963. I should also like to have an assessment of the I.Q. of the Labour Party, after reading the same!

E. K. Sandeman
c/o British Aircraft Corp.
Stevenage, Herts.
England

Polaris weighs about 30,000 lbs. overall; the nuclear warhead has explosive power equivalent to approximately one million tons (one megaton) of TNT. Weight figures for nuclear warheads and other nuclear weapons are classified, but it is obvious that in the case of a few nuclear-tipped U.S missiles—Davy Crockett, Bullpup and Falcon, for example—the warheads weigh considerably less than 500 lbs.—Ed.

Air Force Management

To the Editor:

In your Oct. 7 issue, I noticed a letter from a Mr. Tony Berger blaming non-technical personnel of the Air Force for mismanagement. I not only agree, but I think the matter is much worse than that for the following reasons:

1. Our technology has advanced and is advancing at such a rate that it is difficult even for well-trained technical people to keep up with it. The old-time civil service personnel, trained essentially only in paperwork, are incapable of supervising these technical programs.

Example: For several years a certain laboratory and its equipment was rubber-stamped by Air Force non-technical personnel, until a competent engineer was hired, and then discovered that the instruments and most of the laboratory did not exist. (I have proof for this.)

2. To retain their powerful and fairly lucrative positions, these non-technical people have formed a conspiracy against competent personnel. Good men, if hired at all, are immediately isolated, picked on, prevented from doing their work in their way, insulted by glorified secretaries who order them around, assign them to ridiculous training programs. They are prevented from attending conferences, and they are intimidated. When good training programs are available these are assigned on the basis of loyalty to the supervisor.

Example: A program became available to give further management training to graduate engineers at the expense of the Air Force. This program was awarded on the basis of loyalty and incompetence (probably in the inverse order), it was administered by a secretary, and when the engineers inquired they were insulted and ridiculed. (I have proof of that, too.)

3. To retain their positions, promotions are plums given to those supporting the conspiracy, with the least conscientious man given the most powerful position.

Example: An opening with a higher supervisory position became available. An engineer who had completely accepted the paperwork form of administering was chosen, a man completely subservient to his incompetent supervisor.

4. This type of practice seriously endangers our whole defense and space program. The fighters rolling off the assembly line are poorly quality-controlled and will not stand up as well as if they had been supervised by competent personnel. There are welding problems and holes in tanks that are due to the lax conditions existing in certain airframe manufacturing concerns. Contamination is widespread, and the people who could control it are forced to supervise the work by telephone.

It will require a complete and thorough shake-up to get this organization on an effective and efficient basis, and only when Air Force people will insist that competent men are retained and not fired or driven to resign will we have improvement.

(Name withheld on request)
Hollywood. Calif.

Old Devil Pagination

To the Editor:

We subscribe to your journal and regret to inform you that pages 19 and 35 have been deleted from the Oct. 14 issue, both in our issue and in the one which is sent to the main campus of Syracuse.

Professor Robert J. Shafer
Project Director, Project IPECAC
Syracuse University Research Institute
Syracuse, N.Y.

Postal regulations require that we treat our insert cards as numbered pages. Hence when the insert card is removed it appears that pages are missing.—Ed.

SAN BERNARDINO OPPORTUNITIES

If you seek involvement in the creation of a new missile center, you should investigate the following and other unusual ground-floor opportunities at Aerospace Corporation's new San Bernardino, California, facilities.

RADIO GUIDANCE SYSTEMS
Requires knowledge of data-sensing techniques, data transmission, guidance computations, and system-interface problems; and of analytical techniques to evaluate guidance errors and CEP.

ELECTRONIC WARFARE
Requires knowledge of electronic warfare peculiar to communication systems and to re-entry systems.

COMMUNICATIONS SYSTEMS
Requires knowledge in all facets of military communications, including system-interface problems, and in analytical techniques for the evaluation of system effectiveness.

In order to qualify for these and other positions, you should have at least five years' experience and, preferably, an advanced degree. Qualified applicants are invited to contact Aerospace Corporation, an equal-opportunity employer. Please write to Mr. R. E. Durant, Room 105, P. O. Box 249, San Bernardino, California.

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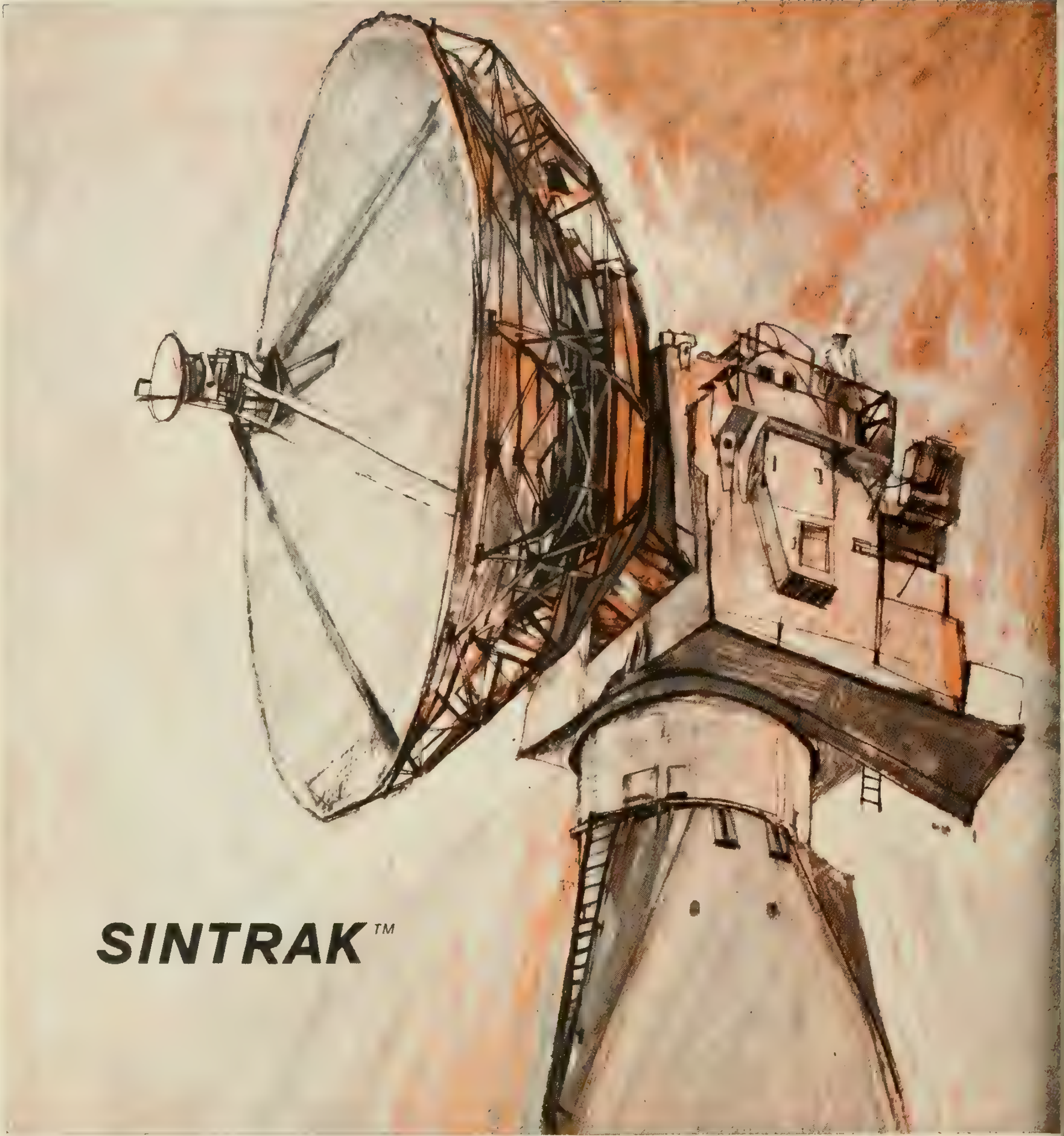

Free world's most advanced shipboard instrumentation tracking radar.

Now aboard USAF Advanced Range Instrumentation Ships (ARIS), SINTRAK — *Sperry Instrumentation Tracker* — radars are the most advanced, precision C-Band shipboard tracking radars available today.

☐ 30 joule transmitter (1 megawatt, 30 microseconds) . . . IRIG beacon codes . . . 30-foot Cassegrainian antenna.

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☐ Group redundancy . . . 0.1 mil rms angular tracking accuracy . . . 50-foot range tracking accuracy.

☐ For information, contact Marketing Manager, RADIATION DIVISION, *Sperry Gyroscope Company, Great Neck, N. Y.*

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The Countdown

WASHINGTON

Dyna-Soar Funds Requested for FY '65

Administration officials report that preliminary Fiscal '65 budget requests from the Dept. of Defense include funds for continuation of *Dyna-Soar* as an experimental spacecraft program. Although keeping the *X-20* project alive, these fall far short of Air Force hopes. The final DOD budget will not reach the Budget Bureau for four to six weeks and the situation still could change.

NAA To Double J-2 Firing Time

North American Aviation's Rocketdyne Division has been awarded an $8.4-million contract to increase the firing duration of the J-2 engine. This new NASA experimental engine improvement program will increase firing time from 250 to 500 seconds.

Work Halts on S-IV Saturn Stage

NASA has spent $166 million on the Douglas-built S-IV second stage of the *Saturn,* on which it now has halted work. No other missions are contemplated for the stage beyond two *Apollo* command and service module boilerplate flights and two launches of the *Micrometeoroid Detection Satellite.*

Four Unmanned Flights Set for Saturn IB

The *Saturn* schedule now looks like this for the later models: *Saturn IB* will make four unmanned flights before taking on the first manned *Apollo* mission in 1966. Eight manned flights are planned. The *Saturn V* will make six unmanned R&D flights, beginning in 1967. Manned flights on the *Saturn V* will begin with the seventh flight, which will be a lunar orbit mission. At least two lunar orbiting flights will be made before the lunar landing.

FBM Subs To Go Five Years Before Overhaul

Estimate of the time between yard periods for *Polaris* submarines has been jumped to five years. U.S.S. George Washington, the first FBM submarine which was deployed in November, 1960, had a scheduled yard overhaul period cancelled last year. It now will not enter the shipyard until mid-1964, almost four years after deployment. Original estimates: three years between major shipyard work. Reason for change: success of the reliability program.

Shillelagh Cost Set in Perspective

Despite an expensive infrared command guidance system, the highly accurate and longer-range *Shillelagh* gun-launched antitank missile costs only about 10 times as much as the conventional 152 mm. artillery shell it replaces in the Sheridan weapon system—if purchased in the quantities now programmed.

New Mk. 84 Fire Control Is Lauded

Rear Adm. I. J. Galantin, chief of Navy's Special Projects Office, predicts the new General Electric Mk. 84 *Polaris* fire control system (M/R, Nov. 4, p. 32) will revolutionize missile fire control. He expects to see the Mk. 84 used also in ASW and air-defense Navy weapon systems.

Test Table Bids Sought by Ames

Bids are due Nov. 15 at Ames Research Center on a three-axis rate table for testing spacecraft instrumentation. The table must be capable of supporting 150 lbs. of instrumentation and have three degrees of rotational freedom.

INDUSTRY

Allis-Chalmers Fuel Cell Seen as Backup

Provision of a backup fuel cell system for Project *Apollo* by Allis-Chalmers is being seriously considered. NASA says the decision on whether a backup system will be used will depend on whether Congress appropriates all of its Fiscal '64 budget authorization of $5.35 billion. Selection of the backup contractor will depend on production capability. GE and Pratt & Whitney already hold fuel cell contracts for Projects *Gemini* and *Apollo,* respectively.

NAA Pushes Redhead-Roadrunner Foreign Sales

An extensive foreign sales campaign is under way for the *Redheaded-Roadrunner* supersonic target missile developed by the Columbus Division of North American Aviation. Target: NATO and other European countries.

How to Lose $16,800—or Win $9,000

Radiation, Inc., has been awarded a $1.6-million NASA contract to provide additional command equipment for Houston's Manned Spacecraft Center. Incentive and penalty could add as much as $9,000 to the Melbourne, Fla. firm's earnings for early delivery—or cost the company up to $16,800 for late delivery.

Late Contract Awards in Industry

Rocketdyne has received a $3.6-million contract from Hughes Aircraft for development of solid-propellant motors for the Navy's *Phoenix* missile . . . Marquardt Corp. has been awarded a $10.6-million initial increment contract by Grumman Aircraft for design and development of the rocket control systems for the Lunar Excursion Module.

INTERNATIONAL

Monkey Business in France

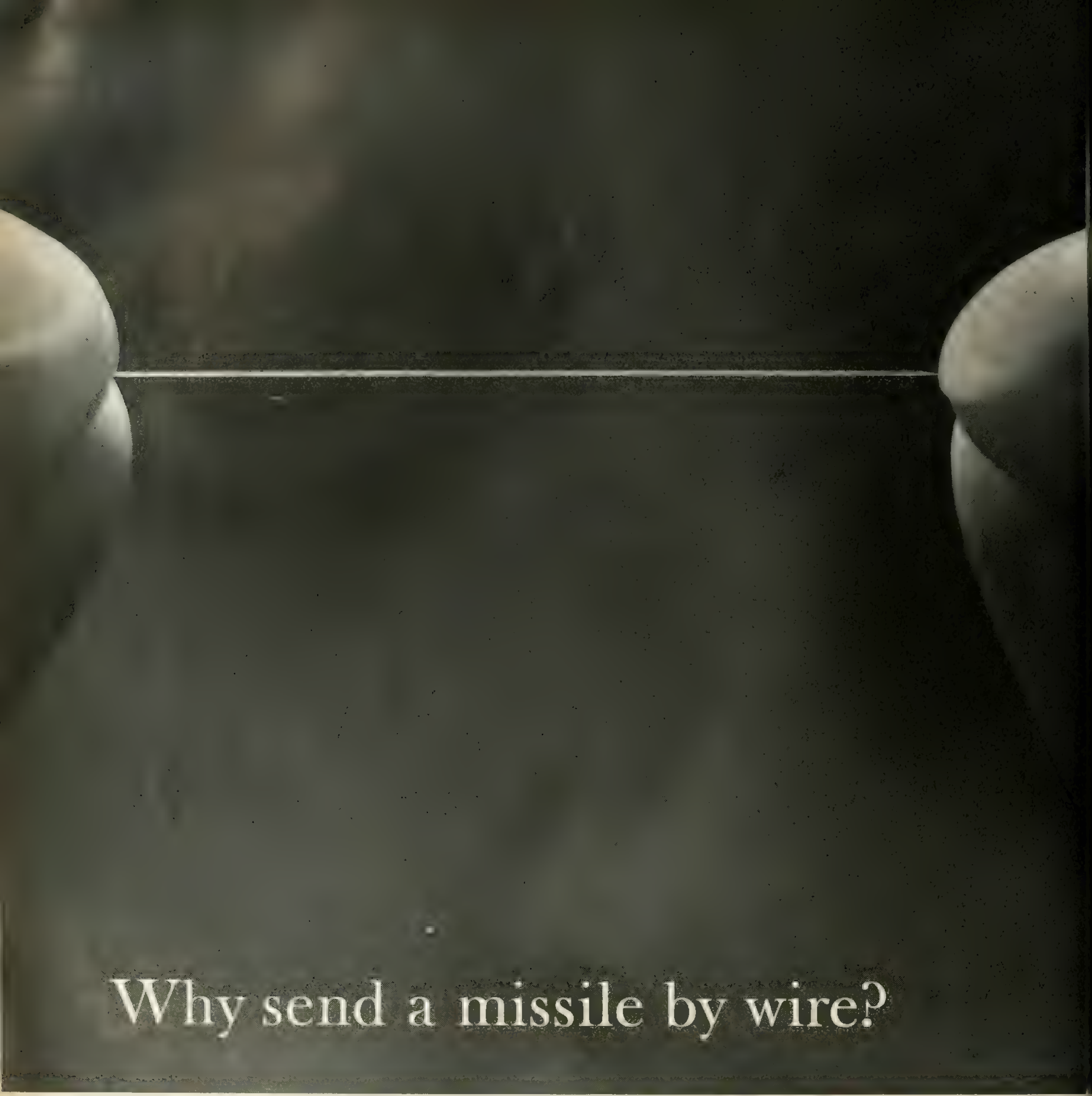
Following successful launching of a cat aboard a *Véronique* rocket at Hammaguir Base on Oct. 18, the French are planning further experiments next year with monkeys, employing *Vesta* launchers or perhaps *Topaze,* the second stage of the *Diamant* missile. *Vesta* is a further development of *Véronique.*

UAR Plans Biological Launches

The United Arab Republic plans to launch and recover living creatures from space aboard rockets developed with the aid of German scientists, according to that nation's news agency. Launch vehicle—and type of creatures—was left unspecified.

First Engines for Diamant Are Delivered

SNECMA has delivered to SEREB the first two Vexin engines for *Emeraude,* first stage of the French *Diamant* satellite launch vehicle.



Imagine an infantryman in battle. In the distance, rumbling into action, is the most dreaded enemy he must face—tanks. They are virtually invulnerable. But his outfit's job is to knock them out.

A tough job. Calling for a unique weapon. One accurate at distance against a moving target. Carrying one-punch lethality—light in weight—rugged. Simple to operate. Easy to carry—on or off infantry vehicles.

This was the scope of the problem faced by Hughes engineers working with the U.S. Army. The solution—almost paradoxically simple in this day of complex weapons–is the new TOW missile system.

With it, the infantryman at last has tactical edge. He can fire from ambush. And surprise is on his side. The gunner aims a telescopic sight at a target then launches the missile which automatically follows his line-of-sight. As the missile travels through the air it unreels two hair-thin wires through which it receives electronic steering signals. Thus constantly "commanded," the TOW missile hits precisely where he aims.

Because these steering commands are sent by wire, they are undetectable. Thus, t
enemy cannot use the guidance comman
to locate the launcher.

The lightweight TOW anti-tank missi
system offers other important advantage
Its simplicity of operation reduces trai
ing requirements. It can be used eith
by dismounted troops or it can be carrie
on various types of vehicles, such as jee
and armored personnel carriers, or o
helicopters.

TOW is characteristic of Hughes a
proach to scientific and technologic
challenge—where every requirement

Creating a new world with electronics

HUGHES

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er, Employment & Manpower, Hughes
rcraft Company, Culver City 55, Calif.

The Missile/Space Week

Wiesner to Step Down

Though no date has been set for his departure, Jerome B. Wiesner has let it be known that he will step down soon as President Kennedy's special science adviser.

Friends of Wiesner have said he has been talking for some time about "getting back to the academic life" as a professor at Massachusetts Institute of Technology.

Wiesner originally agreed to serve President Kennedy for two years in the post originally created during the second Eisenhower Administration. He remained beyond his original agreement at Kennedy's request.

Fuel Cell Development Lags

Pratt & Whitney and General Electric are working to correct fuel cell problems besetting NASA's Projects *Gemini* and *Apollo,* but space agency officials say the delays will not affect program schedules.

William Snyder of NASA's Office of Manned Space Flight says that GE's *Gemini* fuel-cell problems "boil down to better plumbing"—distribution of reactants in the cell's interior.

Snyder said this problem is a normal one of the product-improvement cycle, and that fuel-cell delays will not influence either the early one-to-two-day *Gemini* missions (which will use *Mercury*-type batteries) or the planned 14-day missions later in the program. The GE work is being monitored by the Manned Spacecraft Center.

OMSF's George White admits that the space agency is not as far as it should be in the *Apollo* development schedule to provide adequate fuel-cell lifetime.

P&W is NASA's *Apollo* fuel cell contractor, and the space agency wants more tests to boost fuel-cell lifetime enough to cover the 14-day mission.

Chief *Apollo* fuel cell problems are:

—controlling porosity of the centered nickel plates used as electrodes;

—leakage in cell seals;

—electrical shortages in the cells.

Spacecast Bands Settled

The U.S. and Russia have resolved conflicting views on the issue of allocating radio frequencies for space communications.

Agreement was reached in private negotiations within the International Telecommunications Union Space Radio Conference in Geneva last week.

The step is viewed as a significant one toward further development of satellite broadcasting and other space services, including communications between spacecraft and Earth.

Welsh Urges Continued Push

National Aeronautics and Space Council Executive Secretary Edward C. Welsh has testified that the only alternative the U.S. has to continuing its space effort is to become a second-rate nation.

Speaking before the Air Transportation Association's Engineering and Maintenance Conference in Washington, D.C., Welsh emphasized "we should be pushing vigorously into space, even if no other country had any competence in space technology. It is too great an opportunity and promises too many benefits to be overlooked in a progressive economy. Moreover . . . the space program will pay a handsome profit on the investment."

Welsh elaborated on the mushrooming effect of the space program on the national economy. "Most of the money for space," he said, "is spent in private company activities . . . and it is all spent right here on Earth—not out on the Moon, or Venus, or Mars."

To those who view the program as a drain on the taxpayer, Welsh said that in his judgment "the space expenditures supply a sound investment in this country's future. They furnish employment and profits to private companies; they increase our scientific and engineering capabilities; they broaden the horizons in medicine and improve the equipment for hospitals; they stimulate education and facilitate international relations and they strengthen our national defense."

LEM Model Due at Langley

NASA's Langley Research Center is expected to receive the ⅔-scale mockup of the *Lunar Excursion Module* for its lunar simulation system early next month. Simulated *LEM* missions are due to begin next March.

System prime contractor, Regan & Compudyne, Brooklyn, is to have completed the facility's 250-ft.-high gantry, bridge, crane and control

STL

NEW PROPULSION OPPORTUNITIES

In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

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room by the end of December.

The model LEM will be used to test lunar landing patterns under simulated ⅙-g conditions. Langley test pilots will take part in the initial tests, with astronauts to be brought in later. Preliminary results of the simulated flights are expected by mid-summer.

Shots of the Week

The hurricane-plagued launch of a specially-equipped Air Force *Titan II* finally materialized Nov. 1 from Cape Canaveral. The big ICBM, similar to the one to be used to boost NASA's *Gemini* space capsule, carried a device to dampen the irregular fuel flow that has received much of the blame for the booster's severe vertical vibration (pogo) problems. The shot, conducted by an Air Force crew, successfully lofted an instrumented nose cone 5,000 miles downrange into the target area, but data on the success or failure of the damping system has not been released. NASA is seriously concerned about the pogo problem, which it says could "shake the eyeballs out" of a *Gemini* astronaut.

Other shots of the week:

- The Air Force launched an *Atlas* from Vandenberg AFB, Calif., Nov. 4 in the first shot in a series of re-entry tests.
- The Soviet Union launched *Polyot-1* an unmanned spacecraft capable of maneuvering and changing orbit in space, Nov. 1 (see p. 15).
- An Air Force launch crew successfully fired a *Minuteman* from Vandenberg AFB, Calif., Oct. 31.
- The Air Force fired a *Nike-Cajun* vehicle from Santa Rosa Island, Fla., Oct. 31. The rocket carried a 93-lb. payload containing equipment to measure ambient ion composition in the 200,000-360,000-ft. altitude range.
- France launched a two-stage *Dragon* rocket 310 miles into space from a Sahara test site Oct. 30.

Anticipating the Peace

Sen. George McGovern (D-S.D.), with declared support from nine other senators, is pushing to enact a bill to establish a National Economic Conversion Commission to cope with economic disturbance caused by any future reduction or shift of defense expenditures.

"We can anticipate a leveling off of numerous defense projects, and significant shifts in the character of defense spending," McGovern, who

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recently proposed a $5-billion appropriations reduction, said. To avoid "painful dislocation and loss of job opportunities" in the conversion of a defense to civilian economy, he insisted, "we must develop procedures now for anticipating and meeting these problems."

The commission would be composed of the Secretaries of Defense, Commerce, Labor, Interior and Agriculture; the Chairman of the Atomic Energy Commission; Chairman of the Council of Economic Advisors; plus the directors of the Arms Control and Disarmament Agency and NASA.

It would be charged with studying the contribution Federal agencies and programs could make in converting from defense to civilian activity. The commission would report to the President and Congress within a year after its founding on what action it felt appropriate.

Blount-Sundt Low Pad Bidder

Blount Brothers, of Montgomery, Ala., and M. M. Sundt Construction Co., of Tucson, Ariz., apparently have won the contract to build the first launch pad for *Saturn V* at NASA's Merritt Island Launch Area

The two firms' joint bid of $19,138,000 was lowest among four opened Nov. 5 by the Army Corps of Engineers in Jacksonville, Fla.

The Engineers' earlier estimate for the contract was $20,571,154.

Contract to be awarded covers construction of a three-mile-long crawlerway strong enough to support 17.5-million-lb. loads, installation of launch area utilities, and building of the actual launch pad.

The crawlerway, which will connect the Vertical Assembly Building with the launch pad, will have 40-ft.-wide surfaces 50 ft. apart. These will be 3-ft.-thick crushed limestone on top of a sub-base one to three feet thick.

The launch pad will cover one-quarter of a square mile. The launch position will be reached by climbing an 800-ft. ramp ranging from 7.5 to 48 ft. above sea level.

Ramjet Studied for X-15

Ramjet engines from the Navy's *Typhon* missile are being considered for possible use on the *X-15* rocket plane.

A NASA Flight Research Center-funded study of the engine is underway at Johns Hopkins University's Applied Physics Laboratory. Results are expected by the end of the year.

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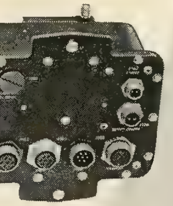
Command flight control equipment by RS Electronics is setting new reliability standards. Remote control of the Navy's KD2R-5 drone shown here is achieved with RSE's Radio Receiving-Control Set which bears the MIL designation AN/ARW-79.

This set consists of an RSE Command Receiver Model 2624AT, proportional Decoder Model 1301A and Model 1805W Accessory Decoder if required.

These components comprise a single, compact airborne package designed and built for Northrop Corporation under U.S. Navy contract. This equipment combines solid state reliability with the packaging advantages of specially designed printed circuit boards.



Model 2624AT/1301A

Operated in conjunction with an airborne gyro to provide automatic flight stabilization, the unit will also control line-of-sight flights without the gyro. The basic package weighs only 4 lbs. 13 oz. and measures 7⁵/₈" high x 7¹/₄" wide x 5¹/₄" deep.

In addition, RS Electronics can provide complete communications links for the remote control of pilotless aircraft and missiles. A typical link would consist of a coder, transmitter, airborne receiver and decoder.

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Cost edge over Titan II . . .

NASA Plans to 'FLOX' Atlas

NASA OFFICIALS plan to seek funds in the Fiscal 1965 budget for the development of an up-rated *Atlas* booster—using a liquid fluorine/LOX mixture in place of the current pure LOX oxidizer system.

The "FLOXed" *Atlas* appears to have the edge in the *Centaur* program over the *Titan II* booster from a cost standpoint.

A *Titan II/Centaur* vehicle increases the escape payload capability of the current *Atlas/Centaur* by 700-800 lbs., while the FLOXed *Atlas* would add only 500 lbs.

But the best estimates available indicate that the *Titan II/Centaur* combination would cost two to three times that of developing and using a FLOXed *Atlas*.

NASA officials said no final decision has been made on the up-rated *Atlas*, but that it appeared to be well ahead of the *Titan II/Centaur* as the booster for unmanned lunar and interplanetary missions.

They indicated that their position is based on a study of the *Titan II* combination recently completed by the Martin Co. and the preliminary results of a feasibility study of the up-rated *Atlas* being conducted with General Dynamics, Inc., and the Rocketdyne Div. of North American Aviation, Inc.

Funding in Fiscal '65, they said, would depend upon Congressional treatment of that budget. Heavy cuts could delay or perhaps kill the program.

The FLOXed *Atlas* approach is based on the premise that the 12-to-18-sec. increase in specific impulse can be achieved within reasonable cost limits. Propulsion experts see no major obstacle to converting the *Atlas* and its engines to the 30%-70% FLOX mixture.

In terms of performance, a FLOXed *Atlas/Centaur* launch vehicle would easily handle the *Surveyor* mission, which is barely within the capability of the current system.

A FLOXed *Atlas/Agena* would be up-rated sufficiently to move into some of the mission areas now planned for the *Atlas/Centaur*.

- **Studies pressed**—Rocketdyne Division of North American Aviation is checking out the mixture on the *Atlas* engines under a $366,593 contract from NASA. The critical engine components involved are the sustainer, vernier and gas generators. The main problem is materials compatibility.

Another $209,625 feasibility contract went to General Dynamics/Astronautics for a study of the effect of the mixture on the *Atlas* oxidizer handling equipment. The emphasis is on valves, venting, filling, boil-off, and shut-off on the vehicle. Ground handling also will be studied.

In the tankage area, the investigation will focus on welds, contamination and passivation techniques. All components in direct contact with the FLOX will have to be passivated.

Preliminary operational studies on FLOXed *Atlas* systems are under way but NASA first must be sure the approach is completely feasible both technically and economically.

The FLOX route is the quickest and cheapest method to capitalize on the extensive fluorine technology now available in industry and government. Bu some NASA experts feel there should be a start on a pure fluorine engine—especially in view of the delays plaguing non-chemical, high-performance uppe stages.

Going straight to an F_2/H_2 engine is the most expensive route—some current estimates run as high as $300 million, including facilities for a 20-30,000 lb. engine. NASA is depending on information from a funded study at Pratt & Whitney to clarify particular engine component development areas.

P&W is well along with an investigation involving FLOX and F_2 on it RL-10 liquid hydrogen/LOX engine. Specific component problems are expected to be defined before the end of the $980,488 NASA-funded study. ■

Poor Reliability Foils Scout Launches

THE *SCOUT* BOOSTER'S poor reliability record of about 60% is disrupting NASA's small payload launch schedule and forcing the Air Force to consider dropping out of its *Blue Scout* program.

The principal problem is the control system for the booster's third stage. NASA frankly admits that it doesn't know what the problem is.

The malfunction has cropped up in two space agency flight-tests and several times in ground-testing. Other troubles are also plaguing the all-solid vehicle.

In the last NASA attempt to launch a *Scout* on a re-entry payload flight, the booster was destroyed when a nozzle on its first stage fell off. Officials, however, believe they have found a solution by reworking the nozzle.

Space agency officials have decided that the *Scout* system reliability of around 60% is not good enough. One Air Force source quoted an even lower figure—54%—and said the AF is studying a possible dropping of its *Blue Scout* program.

A NASA official said that while there haven't been any great dips in the booster's reliability curve, "we want it to turn upward."

As a result, NASA and the vehicle's prime contractor, Ling-Temco-Vought, Inc., are making an intensive study to solve its third-stage problem.

The study has forced a delay in the launch of the United Kingdom's *UK-2* international satellite. Originally scheduled for the fourth quarter of 1963, the flight has now slipped into the first quarter of 1964.

Another *Scout* payload, the *S-66* satellite, is still scheduled to be launched later this year. This indicates that the space agency hopes to solve the problems in the near future.

Cites Polyot I launch . . .

Khrushchev Denies Russian Pullout from Lunar Landing Race

PREMIER KHRUSHCHEV has made it clear that the Soviet Union is still in the race to the Moon and will launch a manned lunar-landing craft as soon as it believes it can be returned safely to Earth.

"We have never said we are giving up our lunar project," the Russian leader told a group of American businessmen visiting in Moscow last week. "You're the ones who said that."

Khrushchev referred to the widespread misinterpretation in the U.S. of his earlier statement on Oct. 25. His remarks then, actually confirming that the Soviets had a manned lunar landing program, were taken out of context and headlined in the U.S. press as a withdrawal from the race. Some officials in the U.S. government initially reacted with predictions of a slowdown in the *Apollo* program (M/R, Nov. 4, p. 14).

President Kennedy, however, told his Oct. 31 news conference he did not see in the first Khrushchev statement "any assurances that Mr. Khrushchev or the Soviet Union were out of the space race at all." He added: "I think we ought to stay with our program. I think that is the best answer to Mr. Khrushchev."

During his interview with U.S. business executives on Nov. 6, Khrushchev was asked by Kendrick R. Wilson, Jr., chairman of the board of Avco Corp., how long it would take the Soviets to achieve rendezvous in space and whether the Russians had given up their lunar project for economic reasons.

"We have no calendar program, no definite date for a rendezvous in space," he responded. "And certainly this latest satellite, this maneuverable satellite (*see accompanying box*) indicates we can contemplate the possibility of that . . .

"I can't say when this is scheduled to happen, because I did not consult with our scientists and engineers in charge of that project to get a definite program.

"In regard to the question of whether we have given up the lunar project for economic reasons or otherwise, we have never said we are giving up our lunar project. You're the ones who said that.

"And when we talk about the technical possibilities of doing this, and when we have complete confidence that whoever is sent to the Moon can safely be sent back, then it is quite feasible. Quite possible. When, I don't know."

- **"Program essential"**—In his news conference remarks, President Kennedy said the Soviets "have made an intensive effort in space, and there is every indication that they are continuing and that they have the potential to continue . . . I think (Khrushchev) said before anyone went to the Moon there should be adequate preparation. We agree with that.

"In my opinion, the space program we have is essential to the security of the United States because, as I have said many times before, it is not a question of going to the Moon. It is a question of having the competence to master this environment. I would not make any bets at all upon Soviet intentions."

- **Mueller hopeful**—A cautiously optimistic estimate of U.S. space prospects was voiced by Dr. George E. Mueller, NASA associate administrator for Manned Space Flight.

"If we have as much success in the future as we have had in the past," Mueller said in an address to the National Capital Section of the American Institute of Aeronautics and Astronautics, "we will achieve for our country a leading position in space within the next few years."

He said the Russian *Polyot I* launch was "beyond our present ability" and the Soviets might have other successes before the U.S. achieves them. But he added that Russia might not have the resources and technology to accomplish a manned lunar landing in this decade. The U.S. has both the resources and ability, he said, provided NASA is adequately supported by the people and the Congress. ■

Polyot May Be in Vostok Weight Class

U.S. OFFICIALS report that it is very possible that the Soviet Union's latest spacecraft, *Polyot I,* is as large as the 10,000-lb. *Vostok* manned spacecraft series.

A maneuverable spacecraft of that size would easily enable the Russians to perform manned orbital rendezvous operations, as well as to inspect satellites.

U.S. officials late last week said they had no indication that the Russians would attempt a rendezvous with *Polyot I.* It appeared that the spacecraft had exhausted its fuel supply. The spokesmen said they were still uncertain of the extent of the spacecraft's maneuvers because the final tracking data had not yet been analyzed.

Nov. 7 was the anniversary of the Bolshevik revolution. There was some feeling in the Administration circles that the Soviets might seize on the opportunity to pull off another of their "space spectaculars."

Polyot I was launched on Nov. 1 into an orbit ranging from 211 to 329 miles above the Earth. Its on-board propulsion was then fired, according to the Soviets, to change its position both up and down before putting it in its final orbit ranging from 210 miles to 892 miles.

The Russians did not say what type of on-board propulsion was used or whether the spacecraft maneuvers were commanded from the ground or by programmed instruction in a computer aboard the craft.

The Soviets did describe maneuverable spaceships as having applications far beyond their use in building large installations in space.

They said they could be steered around radiation zones that might endanger astronauts, and, as weather satellites, could more effectively survey hurricanes by changing course with the moving air masses.

Four assistant directors . . .

Reorganization at MSC To Aid Project Heads

by Warren Burkett

REORGANIZATION of the Manned Spacecraft Center will cut by 25% the number of offices reporting directly to top management.

The cut from 16 to 12 offices will give project managers more effective control over all phases of their projects from engineering to system testing, reliability and flight operations, Deputy Director James C. Elms told MISSILES AND ROCKETS.

He added that the reorganization will affect almost all the center's employees, with the exception of the Florida operations office at Cape Canaveral, headed by G. Merritt Preston.

• **Revamp details**—Under the reorganization, four assistant directors, plus the Florida operations office and the *Gemini* and *Apollo* program offices will report directly to Elms and MSC director Robert Gilruth.

—Assistant Director Christopher Kraft, Jr., who will head all flight operations, including Robert F. Thompson's recovery forces and the mission analysis headed by John P. Mayer, as well as actual flight control, directed by John D. Hodge.

—Maxime Faget, as assistant director for engineering and development, acquired direction of the information and control systems division headed by Barry Graves, who becomes Faget's deputy. Faget's directorate will take added responsibility for subsystem engineering and subsystem contracts.

Other engineering and development divisions include: Guidance & Control, Faget, acting chief; Structures & Mechanics, Joseph Kotanchik, chief; Crew Systems, Richard S. Johnston, chief; Instrumentation & Electronics Systems, Graves, acting chief; Advanced Spacecraft Technology, William E. Stoney, Jr., chief; and Propulsion & Energy Systems, Alex Bond, acting chief.

—Maj. Donald K. Slayton, formerly director of astronaut activities, has been named to the new position of Assistant Director for Flight Crew Operations. He will preside over all areas relating to the training and equipment engineering for the astronauts. Integrated under Slayton will be his former astronaut's office functions, Joseph Algranti's Aircraft Operations and Warren North's Flight Crew Support Division.

—Assistant Director for Administration will continue to be Wesley L. Hjornevik, with Philip H. Whitbeck as his deputy. Duties include responsibility for all administrative and technical services support, as well as supervision of the MSC White Sands Missile Range Operations Office under Wesley E. Messing. Hjornevik will supervise the Personnel, Procurement & Contracts, Management Analysis and Security Divisions. He also has charge of the Office of Technical & Engineering Services and the Office of Administrative Services.

• **Apollo realignment**—The *Apollo* Spacecraft Program Offices will be headed by Dr. Joseph F. Shea and Deputy Director Robert O. Pilard. The office will be reorganized into five functional offices: Program Control, Systems Engineering, Test, Flight Operations and Reliability.

The three positions of managers of the Lunar Excursion Module, command and service modules and guidance and navigation have been retained.

Charles W. Mathews will continue to direct the *Gemini* program office Named as his deputy is Kenneth S Kleinknecht, former *Mercury* manager

• **Mercury experience distributed**—Appointment of Kleinknecht marked the first of several actions that will distribute experienced Project *Mercury* personnel through the *Gemini*, *Apollo* and engineering-development divisions Kleinknecht's deputy, *Mercury* manager William Bland, will go to the *Apollo* office. Elms said other *Mercury* men would go to the project and engineering section in about two weeks

Offices reporting directly to the director's office are Center Medical Operations, Legal, Reliability & Quality Assurance and Public Affairs.

Elms said "Part of our job is to develop future programs. We could use 100 or 1,000 persons to do future planning. The reorganization will enable u to do the job with the people we have or with very few additional persons." ■

First Gemini Booster Goes to Canaveral

FIRST TITAN II launch vehicle for NASA's Gemini program is inspected by Jack Lovell, Martin Co. quality control expert. The booster will be mated to the capsule at Cape Canaveral for checkout in preparation for first unmanned flight early next year.

Abort system first . . .

Apollo Hardware Flights Beginning at White Sands

FIRST FLIGHT TESTS of *Apollo* spacecraft systems are beginning at White Sands, N.M.

The first test scheduled late last week was a check of the off-the-pad abort system for the three-man spacecraft. Scheduled for no earlier than Nov. 7, the flight is designed to test escape rockets and the spacecraft's parachute recovery system.

If successful, it will be followed next spring by an in-flight abort test of the *Apollo* boilerplate using the *Little Joe II* booster. Three other *Little Joe II's* are available for similar tests later with actual *Apollo* spacecraft flight models.

- **Flight details**—The flight plan for the first abort test calls for the boilerplate *Apollo* command module to be powered to an altitude of 4,900 ft. by the launch escape motor. A pitch motor with a thrust of 3,400 lbs. is used to push the Command Module away from the launch pad.

The launch-escape motor burns out with the vehicle at 4,100 ft.

The vehicle continues upward on a ballistic trajectory to an altitude of 4,900 ft. when the jettison motor, developing 33,000 lbs. of thrust for one second, ignites and releases the launch-escape tower.

The drogue chute deploys at 4,700 ft., assisting in orienting the blunt end of the Command Module forward for main chute deployment.

The drogue chute releases at 4,150 ft. and the pilot parachutes deploy and extract three main chutes.

The main chutes are fully inflated at 2,800 ft. and an equilibrium descent of approximately 24 ft. per second is established.

- **Data recovery critical**—Recovery of the tape-recorded data immediately after impact is considered the primary requirement of the flight. The entire launch vehicle is to be recovered including the Command Module, the recovery parachutes, forward compartment cover and the entire launch-escape system for post-flight analysis.

The boilerplate Command Module is of conical design approximately 135 in. high and 154 in. in diameter at the base, with a nominal weight of 9,000 lbs. It is constructed of an aluminum alloy.

The Earth-landing system consists of pyrotechnics and pyrotechnically-actuated devices, one conical ribbon drogue parachute, three ring-sail main parachutes, deployment bags, bridles, three pilot parachutes, risers, an impact switch and a sequence controller.

The drogue parachute is 13.7 ft. in diameter and is opened by a mortar. The main parachutes are 88.1 ft. in diameter and are deployed by three mortar-deployed pilot parachutes that extract the three main parachutes.

- **Launch escape system**—The launch-escape tower is a truncated rectangular pyramid constructed of welded tubular titanium alloy approximately 120 in. long, with the base measuring 46 x 50 in. The tower forms the intermediate structure between the Command Module and the escape and tower jettison motors.

The launch-escape motor is a solid-propellant motor with four nozzles canted 35 degrees. The motor weighs approximately 4,764 lbs., of which approximately 3,200 lbs. is fuel.

The tower-jettison motor propels the expended launch-escape system away from the Command Module to preclude interference with the operation of the Earth-landing system. The tower-jettison motor develops 33,000 lbs. of thrust for one second and weighs approximately 540 lbs.

The tower-release mechanism consists of four explosive bolts. Each bolt contains a single explosive charge and employs a dual ignition feature to increase reliability. ■

LEFT: Boilerplate Apollo Command Module and escape tower mated and being made ready for launch at White Sands Missile Range, N.M. RIGHT: Boilerplate being placed over Apollo configuration housing drogue and main parachute.

Demands changes . . .

House Leader Cites R&D Mismanagement by DOD

Price lists lack of objectives, poor cost estimates and 'musical chairs'; committee scrutinizing programs

THE CHAIRMAN of a Congressional committee which has been holding closed-door hearings on Defense Dept. research and development programs has warned that considerable improvements must be made in the management of R&D.

Rep. Melvin Price (D-Ill.), chairman of R&D subcommittees for both the Joint Atomic Energy Committee and Armed Services Committee, said the day was past when errors in R&D management could slip by with relatively little notice. He said the government was not a "money tree" and that improvements will have to be made in several areas lest Congress and the people begin to discredit those who guide the vital research and development programs. "We must act now, so that the opportunity for corrective action will not fall into hands which are less considerate and less understanding."

Price made his remarks at a Washington, D.C., meeting of the American Institute of Aeronautics and Astronautics and the Air Force Systems Command.

He pointed out that Congress already has begun taking steps towards remedying the R&D problem. He cited the increasingly close scrutiny of the national space program, sharp cuts in R&D funds, and the appointment by the House of a Select Committee on Government Research.

- **Power at hand**—Price's own Armed Services subcommittee will have a great deal of power to implement his suggestions next year, since it will have authorization control over a considerable portion of the Defense budget. It now has legislative oversight over all DOD R&D; previously, this control was limited to aircraft, missiles and ships. The committee has been meeting regularly in closed sessions to study the programs of the Air Force, Army, Navy and Marines, and there is every indication that it will take its authorization duties next year with a great deal of seriousness.

Price indicted the nation's R&D effort on these counts:

—Lack of objectives—In the *Pluto* reactor program, he said, Congress was told repeatedly that the main problem was proving the feasibility of the reactor portion of the system. "Now, as we approach an answer to the reactor problem, we are told that the *Pluto* concept really doesn't depend on solving the reactor problem at all, but rather on the aerodynamics of the *Pluto* vehicle." Price also said he would watch with interest to see the effect of the Khrushchev utterances on space, since the President stated May 25, 1961, that the national objective was to land a man on the Moon and return him safely to Earth before the end of this decade.

—Poor estimating of R&D costs.—Price said he really believed there was something more serious than poor estimating. "I believe in many instances there have been deliberate attempts to sell projects to the government by underestimating project costs."

The Congressman said he recently scanned a list of 100 NASA projects, each of which originally had been estimated to cost $1 million or more. He reported that there were increases in cost in 90 of these, ranging up to a figure in excess of 1000%.

"Unless well-defined programs are presented to the Congress, the path to authorization will be rocky," he said. He realized that there must be a certain amount of flexibility in cost estimates, schedules and other project plans before work is started, Price added, but unless a fairly well-scoped research and development effort is defined early, little can be expected from it.

—Blurred and vague management responsibility—Management musical chairs has impaired a number of programs, Price said. He pointed to the Army reactor program, which has had six directors in five years, as an example of management turnover creating major problems.

Industry has a special responsibility, the chairman noted. Since many large contracts are awarded on the basis of certain talented people in the company, he declared, a diversion of key people to other pursuits after the award amounts to an unjustifiable breach of moral obligation "if not a break of a legal obligation."

- **DOD decisions hit**—Price strongly criticized the Pentagon "computer jockeys" in making the decision not to use nuclear power in the next aircraft carrier. He said this illustrated the most inexcusable wrong of all—"the failure to use and apply the results of a successful R&D program in actual operating units."

The Congressman also put in a bid for manned aircraft, leading ultimately to the *Aerospace Plane* concept. ■

NASA Funds May Clear by Thanksgiving

NASA'S APPROPRIATION bill may be through Congress by Thanksgiving, Chairman Warren G. Magnuson (D-Wash.) of the Senate appropriations subcommittee said last week.

Magnuson reported that the subcommittee has begun marking up the Independent Offices Bill, of which NASA's budget is part. This is expected to go to the full committee this week, and an attempt will be made to get it to the floor during the week of Nov. 18. Since appropriations bills have precedence over other legislation, the bill has a chance of being brought up on the floor in spite of civil-rights or tax-bill wrangles, unless Senate leadership chooses to hold it back.

NASA is said to be asking only $125 million over the House bill, which provides $5.1 billion. If the Senate concurs that this is the proper amount, it probably will write a bill for $5.3 billion, so that the conferees will arrive at a figure of about $5.2 billion.

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STEPHE

HELP WANTED—MEN

UTC

USAF TITAN III C — LONG RANGE PROJECT

e are prime contractor for the first stage of the USAF an III C, which includes two 120-inch diameter segmented lid propellant rocket motors. Together, these motors will velop more than 2 million pounds of thrust at lift-off— er 80% of Titan III C's total thrust. We offer challenging ositions to qualified men for work on this space vehicle and r R & D and production in other solid, liquid, and hybrid cket motor programs.

LECTRONIC ENGINEERS—INSTRUMENTATION

The job: To develop control systems instrumentation. Required: Knowledge of transduction, instrumentation, data acquisition and processing. Degree: BS in EE or Physics. Experience: A year or more.

OLID TEST ENGINEERS

The job: To test solid motors . . . all that the word implies, from start to finish. Methods, equipment, procedures. A variety of assignments available, depending on degree and experience.

STRUCTURAL ANALYSIS ENGINEERS

The job: Stress analysis on big, big rockets. Required: Experience in complex shell and semi-monocoque structures, knowledge of scale model static and dynamic analysis. Degree: BS and 1-5 years experience.

you

VEHICLE SYSTEMS ENGINEERS

The job: Apply your knowledge and experience in wiring systems, ordnance checkout, performance analysis, trajectory and load study, vehicle and structure design, inadvertent separation systems. Required: BS in ME, AE, or Physics.

LIQUID AND ENVIRONMENTAL TEST ENGINEERS

The job: To build, test, and evaluate ablation chambers, tankage, TVC, and liquid ignition systems and perform environmental tests. Required: BS and experience appropriate to assignment.

me

STRUCTURAL DYNAMICS

The job: To study space booster's response to high intensity noise, turbulence, transportation dynamics, and other steady and dynamic loads. Work is theoretical and experimental. Required: Advanced degree and 1-5 years experience.

SENIOR DESIGN ENGINEERS—AGE

The job: AGE systems design, analysis, procurement, checkout. Required: BSEE with about four years experience in AGE test and ground instrumentation and support systems.

Contact Mr. Jay Waste, Dept. B

We acknowledge all inquiries and treat them confidentially. We arrange interviews for qualified applicants. We're an equal opportunity employer. U.S. Citizenship Required.

UTC

United Technology Center

DIVISION OF UNITED AIRCRAFT CORPORATION

P. O. Box 358 • Sunnyvale, California

Took Tommy to the dentist, back soon. Meanwhile, look what I found in this morning's paper !!!! . . . .

---

gust 5. Call Jim Ferguson, QU 7-3301.

WILLY MAYS, I bet my shirt you'd hit .330. Don't lv me out in the cold. A fan.

REWARD OFFERED for bright ideas pertaining to solid or liquid rockets, hybrid engines, solid propellants, AGE, etc., etc. See UTC advt, Classification 51.

UTC WIVES GOLF CLUB now forming. Weekly foursomes of beginners, intermediates, and experts. Club rental and instruction arranged. Details, call Betty McCormick, QU 8-7659, days or eves.

SPECIAL NOTICE FOR SHOOTERS PISTOL MEET—SUNDAY. This Sunday afternoon at 2:00 there will be a special pistol meet between a team from United Technology Center's Pistol & Rifle Club and the Sixth Army Pistol Team from the Presidio of San Francisco. This event will be held at the Sunnyvale Police Academy. There will be a special display of trick shooting by members of each team before the match. Also: Old West fast-draw exhibition and re-enactment of a Dodge City shootout. Free admission, everybody welcome. Children under 14 must be accompanied and supervised by parents.

YOUNG MEN ATTENTION UTC Engineer with rs' degree will trade tutoring (HS or Col help in excavating fo yard swimming pool. Harry Osborne, QU 8- eves.

GOURMETS' HT

YOUNG MARRIE OUP now being form tour San ous restfe. Trips twice a ation ar- member. 7-3447.

N being first TC

SEASCOUT formed in meeting in bldg. Friday 7:30 p.m. ents and boys 11 and over invited to attend. Former Seascouts welcome and needed. Refreshments served. More

secure portation in the form pools, etc., if you live in the Santa Clara Valley. We also have organized BOWLING LEAGUES for men and women, an AIRPLANE CLUB with reduced flying and instruction rates, a GOLF LEAGUE a BRIDGE CLUB. Ot recreational and leis activities also available. OUP TRAVEL now ar- ranged for fam its to Disneyland, ART LEAGUE begin next month.

DISCOUNT TIC available for Giant all games, SF theater ncerts, and special ions. UTC needs d engineers and ns. See current ments in UTC ad assification 51. Help ed—Men.

HOUSE ONVERTIBLES, Sun- largest, friendliest outlet dealing ex- y in California's fa- the convertible. All s, all models from to shoehorn imported . Open all day Sunday. use of Convertibles, El amino Real, Sunnyvale. sk for Sam.

NTAGE CAR CLUB of San Francisco Peninsula will not meet this month. Next regular meeting will be held following Concours d'Elegance in Monterey on the 25th. Details from Secretary, QU 8-6681.

FOR SALE: Hi fi console. Stereo with 2-30 watt amps. tuner with AFC. record player. system (2 contains wooer, horn tweeter. All in beautiful walnut cab. Make offer. Charles Webb QU 8-1135, eves & weekends.

SNOWSUITS sizes 2 and 4. Used one week in mountains. Make offer. QU 8-9454.

BABYSITTING POOL BEING FORMED by UTC wives in Sunnyvale and elsewhere in Santa Clara Valley. Object: Low-cost, no-cost baby tending. New members welcome. Call Pat Robinson,

th Norwa 175 hrs 3½ gal QU 8-7 Belmo

HOUSEBO living, ley, re the B Priced eves.

SACRIFIC boat. sailing low as (Orig. QU 8-

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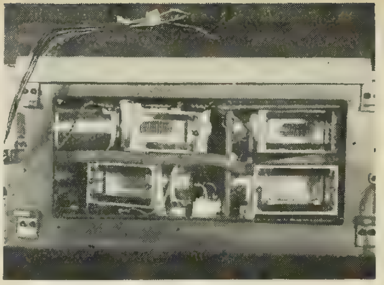
OR RENT—3 bdrm. furnished resort cottage, shower, TV, on the Bay, Robinson Beach; good fishing close by, swimming in season. Schock Realty QU 8-1414,

WEEKLY CAR POOLS FORMING Peninsula engineers and scientists forming car pools to Berkeley campus, Univ. of Calif. to enjoy stimulating solid-state lectures,

CQ, CQ, CALLING CQ Ham rig just arrived from the East. Now setting up shack. Like to meet local hams. Be on the air by Sunday night, testing gear and antenna on 20 meter band. Talk



Here, in Lockheed Missiles & Space Company's Physical Sciences Laboratories, scientists are engaged in a comprehensive space physics research program embracing experimental and theoretical work in space radiation, aurora, atmospheric structure, geomagnetic micropulsations, x-ray astronomy, and the propagation of electromagnetic waves in space. Experimental programs include the measurements of geophysical and space properites, both in space and in the laboratory.

Currently, measurements of variations on the earth's magnetic field are being made at remote islands in the Pacific Ocean, providing clues to the effect of solar activity on its shape and stability. The influence of solar wind on the geomagnetic field is also being investigated in laboratory experiments, by bombarding magnetic fields with clouds of highly ionized gases.

Scientists at Lockheed are engaged in a continuing program of designing and placing density gages, mass spectrometers, ion traps, and similar instruments on space vehicles to measure the density, composition, and temperature of matter in space. These experiments lead to a better understanding of the chemical reactions occurring in the atmosphere high above the earth.

Important investigations of the low energy x-rays emitted by stars are being carried out and interpreted to give information on the structure of stellar coronas.

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engineering • Electronic engineerin
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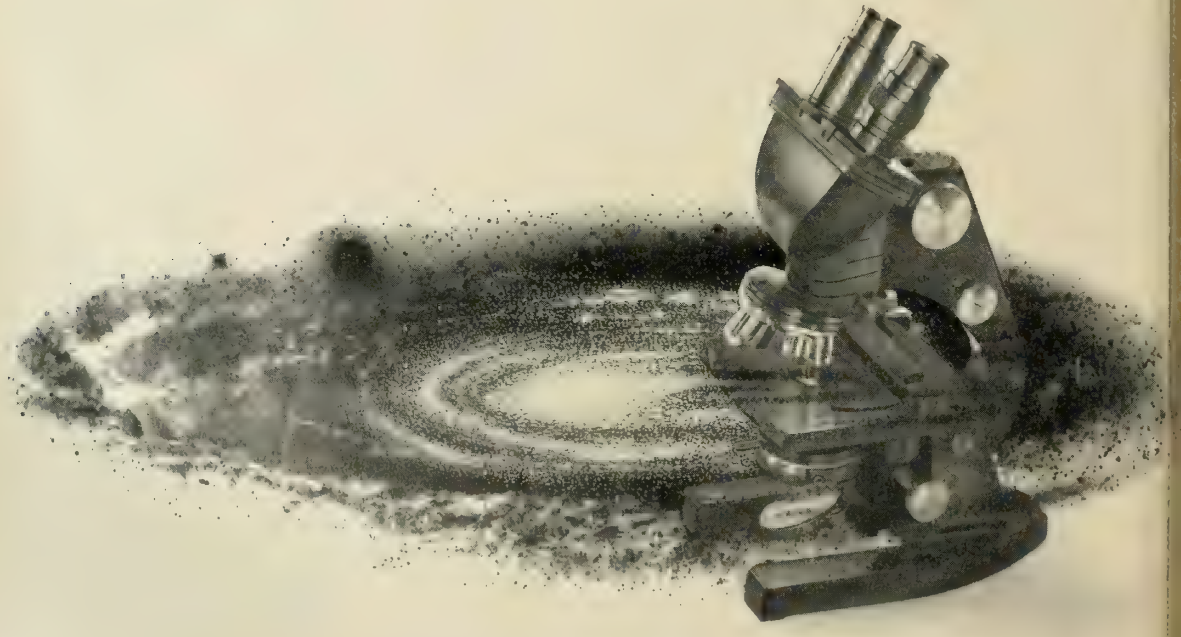
LOOK AT LOCKHEED IN SPACE PHYSIC

Continuing investigation of matter and forces in space



Technical Countdown

SPACE MEDICINE

New Bios Task Goes to Avco

Latest of the *Biosatellite* experiment contracts has gone to Avco Corporation's Research and Advanced Development Division, to study orbit effects on neurospora fungi. The experiment will employ a time-lapse photographic system that will continually monitor the organisms in flight, to see if the lack of Earth reference and diurnal cycle has any effect on its traditionally rhythmic growth. Contract amount is $76,759.

AF Resorts to Bio-computer Processing

Scientists at the Aerospace Medical Research Laboratories at Wright-Patterson AFB have turned to a high-speed digital computer that can perform 100,000 additions or 50,000 multiplications per second and ultimately will store 20,000 four-digit numbers for basic biological and bionics research. The computer will be used to record biological signals—heartbeats, etc.—and accurately isolate them from the considerable background noise by comparing each with a statistical model.

Respiratory Lab Under Contract

A million-dollar facility to study respiratory toxic hazards will be installed at the Aerospace Medical Research Laboratories, Wright-Patterson AFB, by Aerojet-General Corp. The research unit will consist of four 12-ft. transparent domes equipped with airlocks that can operate for continuous periods up to 90 days. Trace cabin contaminants, hazardous ground propellants and other gaseous products will be investigated. Aerojet will provide a staff of about 14 scientists and technicians, headed by Dr. J. D. MacEwen, under a three-year contract.

Air Force in Apollo Life Sciences

The Air Force is now doing 15 tasks for NASA—half of which are directly in support of *Gemini* and *Apollo*. Eight will be performed at the School of Aerospace Medicine (Brooks AFB, Tex.), six at the Aerospace Medical Research Laboratories (Wright-Patterson AFB, Ohio) and one at the Aeromedical Research Laboratory (Holloman AFB, N. M.). The *Gemini* and *Apollo* work includes respiratory studies at different atmospheres, medical selection, thermal balance of suited astronauts, impact forces, nutrition, weightlessness orientation and thermal evaluation of a prototype *Gemini* suit.

ADVANCED MATERIALS

New High-Temp Insulator Perfected

An ablative material called Thermobar 480 will hold a backface temperature of 100°F for almost 70 seconds when a 0.25-in. thick sample is exposed to a 6,000°F oxy-acetylene flame. The material is a development of Fargo Rubber Corp., Los Angeles. The specimen had a thin instrumented aluminum plate bonded to the back surface. After five minutes exposure, the backface temperature reached 400°F. The rate of ablation was 0.00087 in./sec. during the entire run. No information on material composition is available.

Investment Casting Center Set Up

Arwood Corp. is establishing a technical center devoted exclusively to advancing the art of investment casting. The Brooklyn, N.Y., facility will cover pure research and development in the newer alloys, including high-conductivity copper, chrome copper and maraging steels. The other major function of the center will be directed toward solving engineering problems arising from production runs at any of the five Arwood plants. The technical center will work under both industrial and government contracts in projects related to investment casting.

40-in. Vacuum Valve in Operation

A 6,000-lb., 40-in. valve assembly capable of holding atmospheric pressure on one side of the gate seal and a 5×10^{-7} mm. Hg. vacuum on the other will soon be in operation at Aerojet-Sacramento's new space simulation chamber. Designed and fabricated by Grove Valve & Regulator Co. in cooperation with Aerojet's Aetron Division, the unit is a full-opening valve system incorporating a cold-trap elbow cooled to liquid nitrogen temperatures. Grove used a nonrising screw stem in place of sliding seals. A retracting gate is brought into the fully-closed position by a jacking arrangement within the valve body.

GE Markets 1,400° F Inorganic Mica Material

A proprietary inorganic bonding process combined with sheets of mica in a new high-temperature laminate may fill the insulation gap between organic materials and ceramics. General Electric Insulating Materials Department in Schenectady, N.Y., developed the process, which can supply sheets up to 0.125 in. thick on a commercial basis. Capable of being machined and molded, the mat will withstand temperatures up to 1,400°F and has an electromagnetic wave transmission of 95%. Running about 66% of the weight of ceramics, the mat has thermal conductivity properties as follows: perpendicular to laminations, 0.000432 cal./cm^2 sec. °C cm.; parallel to laminations 0.00523 cal./cm^2 sec. °C cm. Aimed at the thermal environment between 500° and 1,400°F, the mica mat will withstand electrical surges up to 1,500 volts per mil. The material displays a uniform low dieclectric constant and low loss tangent. Its flexural strength tests to 28,000 psi.

PROPULSION

Zero-G Met With Magnetized Fuels

A NASA Lewis Research Center scientist has succeeded in stabilizing iron oxide particles in colloids of carbon tetrachloride, N-heptane and JP-4 so that the liquid mass is affected by a magnetic field. S. Stephen Papell suggests putting an electromagnet in the pump area of a fuel tank in a weightless environment. Activating the magnet just before starting the engine would pull the magnetized fuel to the pump area. Research is proceeding into cryogenic propellants and the effects of magnetized fuels on combustors.

Thiokol Boosts Solids I_{sp}

Two small rockets containing a radically up-rated solid-propellant formulation were successfully tested by Thiokol Chemical Corp. at the firm's research and development facility near Brigham City, Utah. The propellant has a new ingredient that is reportedly responsible for enough of an increase in performance to make the solid competitive with the newer liquid propellants in both impulse and thrust. Thiokol did not release any details on either performance or the nature of the propellant.

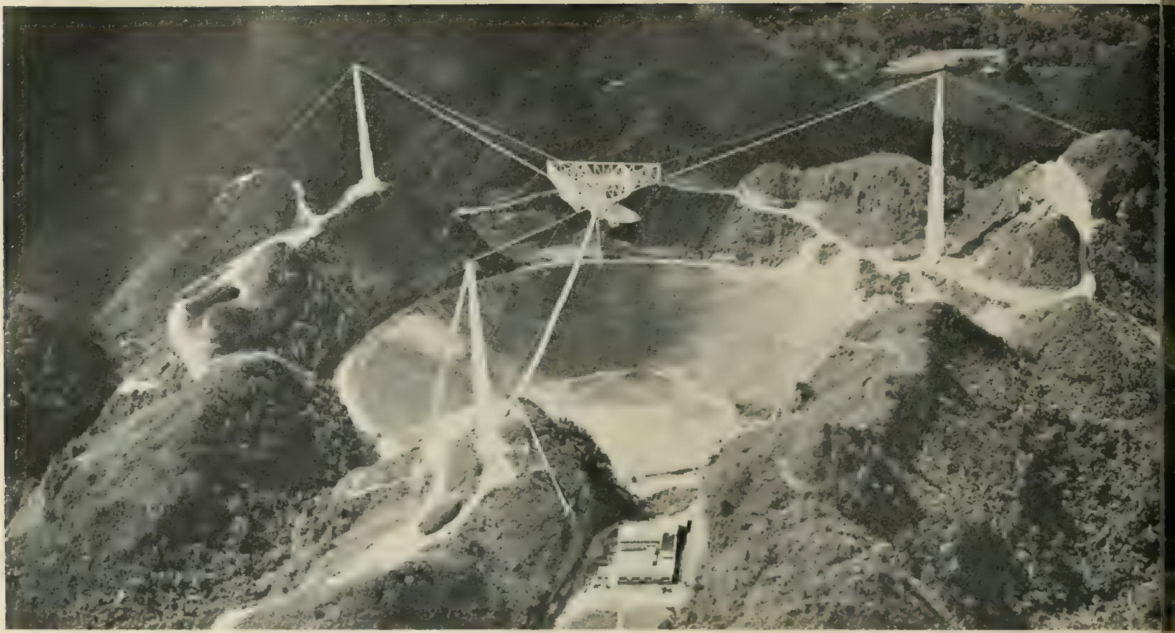


PHOTO of Arecibo Ionospheric Observatory shows almost impenetrable "haystack-hill" terrain formed by collapse of subsurface limestone caves in prehistoric times.

Observatory in Puerto Rico Will Far Surpass Existing Big Dishes

Newly dedicated facility operated by Cornell U. for AF and ARPA begins solving many secrets of near universe

by Charles D. LaFond

ARECIBO, PUERTO RICO—The true potential of the Air Force/ARPA 1,000-ft.-dia. astronomical radar telescope here may not become apparent for many years, but scientists already claim it will better Britain's Jodrell Bank dish by at least 16 times and offer a 10,000 times improvement over the big Millstone Hill antenna in New England.

Dedicated at this isolated site recently and officially turned over by Dr. Eugene G. Fubini, Assistant Deputy Director of Defense Research and Engineering, to Cornell University for operation, the long-awaited electronic space probe soon will reveal many secrets of the near universe.

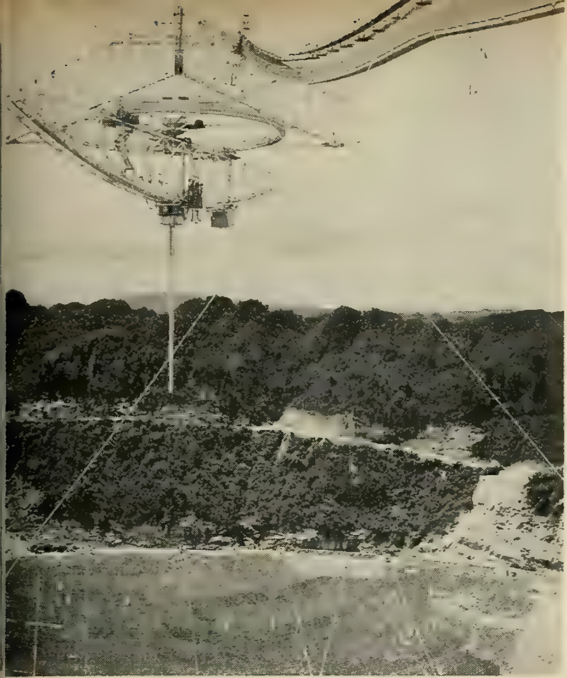
Three principal areas of research will be carried out by Cornell under the direction of Professor William E. Gordon, who originated the concept for the Arecibo Ionospheric Observatory nearly five years ago:

1) The ionosphere will be repeatedly probed (during 50% of the operating time) with the high-energy radar to measure electron and ion temperatures, ionospheric density, and ion frequency, with emphasis in the F region (at roughly 150 miles altitude). It is hoped that an intensive study of the region will provide a better understanding of this radio propagational medium, particularly as associated with military communications and tracking problems.

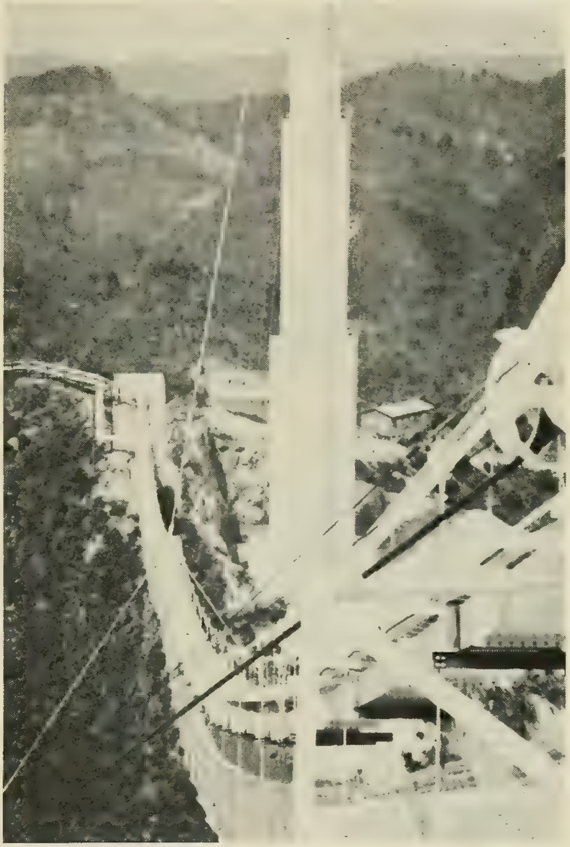
2) Operating initially at 430 mc, the 2.5-megawatt-peak transmitter output will be used for radar studies of the heavens out to about 400,000 km. Although essentially limited to the region of the Sun's planets, the instrument will help clarify problems in celestial mechanics and provide a 10 to 100 times improvement in range accuracy for these bodies. Also, lunar studies should provide a better understanding of that body's surface properties, roughness and distribution of reflectivity.

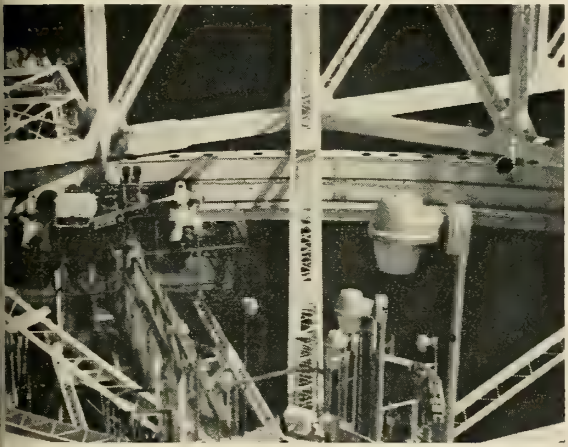
3) For radio astronomy, the big dish's vast improvement in sensitivity will provide a keen ear for natura deep-space RF emissions.

Started over four years ago, the program was funded by the Advanced Research Projects Agency and administered by the Air Force Cambridge Research Laboratories. Cost of the project during this period grew from $4.5 to $9 million.



LEFT: Triangular steel-truss platform, 216 ft. on each side, supports 129-ft.-dia. azimuth track. Beneath track, 304-ft. crescent feed-arm truss provides elevation settings for 96-ft. feeds slung below carriage houses. BELOW: Catwalk gives access to suspended platforms and supports antenna waveguide.





LEFT: Two 20-hp elevation drives and one 25-hp azimuth drive (center, left) supply elevation slew rate of 5 degrees/min. and an azimuth slew rate of 50 degrees/min. (to 540 degrees before reversal).

Principal engineering firms united in the joint venture included: Von Seb, Inc. (mechanical design and general administration); DECO Electronics, Inc. (electrical design); Severud-Elstad-Krueger-Associates (general consultation); and Praeger-Kavannaugh, Engineers (civil and structural design and inspection and technical coordination).

The transmitter was built by Energy Systems, Inc. (formerly Radiation at Stanford) under a half-million dollar subcontract to Cornell.

- **Natural bowl**—Built on coral limestone in the extremely mountainous terrain along Puerto Rico's central northern coast, the antenna is set in a natural 1,400-ft.-dia. bowl. Spaced 120 degrees apart about the perimeter are three reinforced concrete towers—two 268 ft. high, one 390 ft. high. By means of four 3-in.-dia. main cables from each tower, the 550-ton moveable feed structure is suspended.

By moving the 96-ft.-long aluminum slotted conical feeds in both azimuth and elevation over the 18.5-acre spherical dish below, a ±20-degree scan can be obtained.

System average power is 150 kw; pulse repetition rate—up to 1,000 cycles; pulse widths—from 2 microseconds to 10 milliseconds; and beamwidth —10 minutes of arc. The transmitter is also capable of producing a 100-kw CW signal.

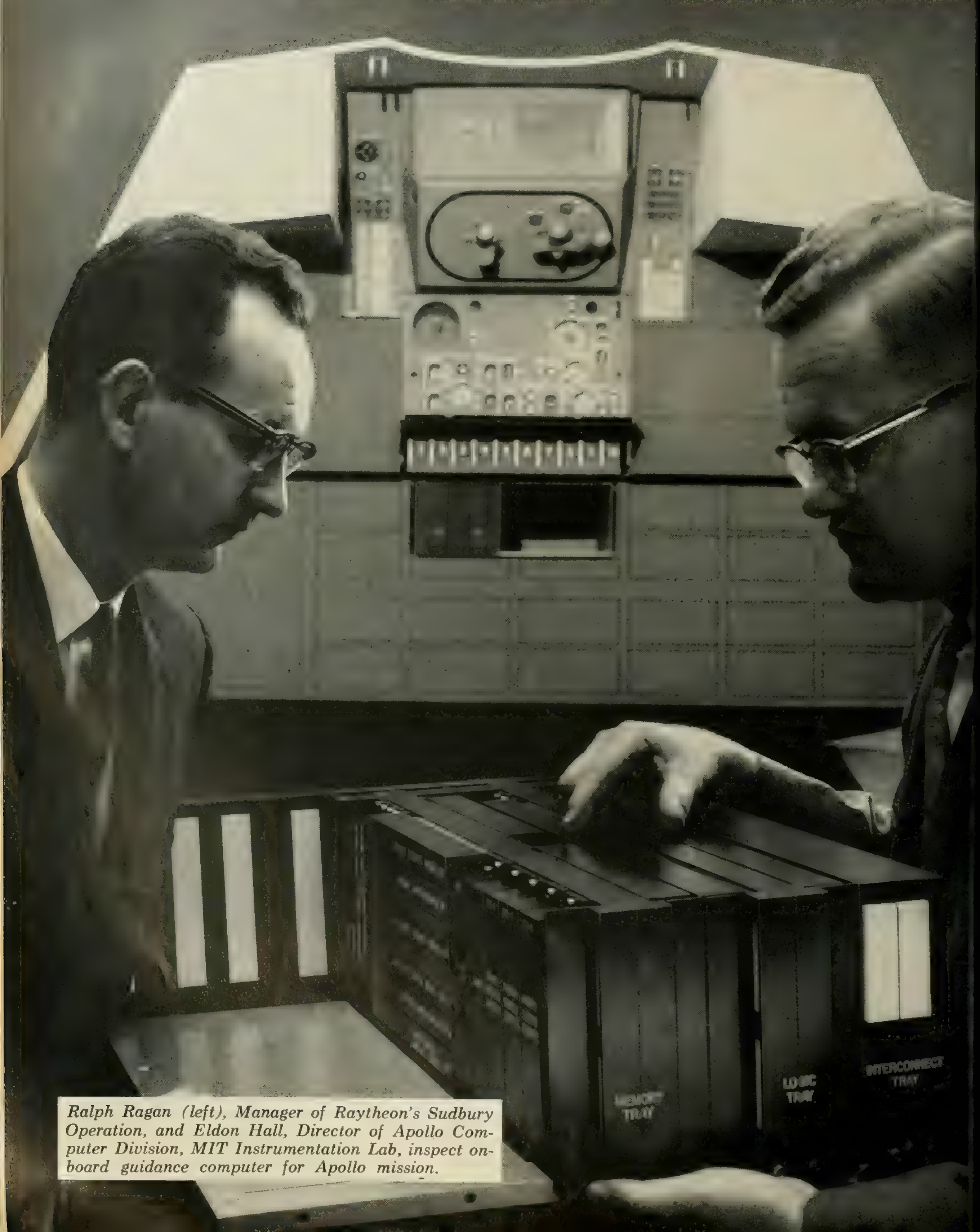
The 1,000-ft.-dia. steel mesh reflector, located roughly 435 ft. below the two carriage houses, has a radius of curvature of 870 ft. and measures 160 ft. in depth from its upper circumference to the center plane. Reflector surface, according to Cornell officials, was within a specified erection tolerance of ±1 in.

The suspended platform and feeds are capable of operating in winds up to 30 mph and throughout a ±15° F temperature change. The structure, when locked and with the feeds removed and stored below, can withstand hurricane winds up to 150 mph. Feed removal, however, is a 12-hour operation.

In the future, different antenna feeds will be installed, Professor Gordon says, to permit the use of other operating frequencies. In particular, operation at 1,420 mc (the 21-cm. hydrogen line) will be desirable (to study, for example, the spiral nebula in the constellation Triangulum) using Doppler shift techniques. ■

MIT/RAYTHEON STATUS REPORT:

APOLLO Guidance


MEMORY TRAY
LOGIC TRAY
INTERCONNECT TRAY

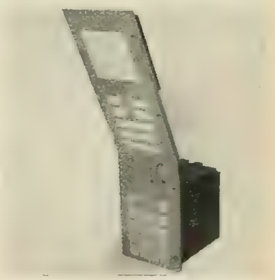
Ralph Ragan (left), Manager of Raytheon's Sudbury Operation, and Eldon Hall, Director of Apollo Computer Division, MIT Instrumentation Lab, inspect on-board guidance computer for Apollo mission.

Predicted Reliability Increased More Than 2:1 ...Contract On Schedule

By incorporating the latest rope memory module and integrated micrologic techniques into Apollo's on-board guidance computer, the MIT/RAYTHEON team has *doubled* predicted reliability of the system with no loss in scheduling time.

Drawing upon a background of successful joint effort in developing the reliable Mark 2 Polaris missile guidance computer, the MIT/RAYTHEON team is striving for similar fault-free operation of its Apollo guidance system. The operating computer, less than 1 cubic foot in size, will provide mid-course navigation and guidance data for NASA's Apollo spacecraft mission.

The MIT/RAYTHEON-developed computer contains an extremely dense, low-powered, fixed memory of 5,000 bits/cubic inch. In flight, the astronaut will operate the computer through a 16-button coded keyboard. In case of input error or an "unacceptable" order, a light will warn the astronaut to erase the error. When the command is correct, he pushes an "enter" button and the computer will take over, using inputs fed to it automatically from the other subsystems in the craft.



Keyboard for Apollo's on-board guidance computer.

The working relationship of the MIT/RAYTHEON team in developing and producing the computer, its displays and keyboard, and its pre-flight ground support equipment, represents a truly unique capability in space age guidance and control. *Space and Information Systems Division, Sudbury, Mass.*

RAYTHEON

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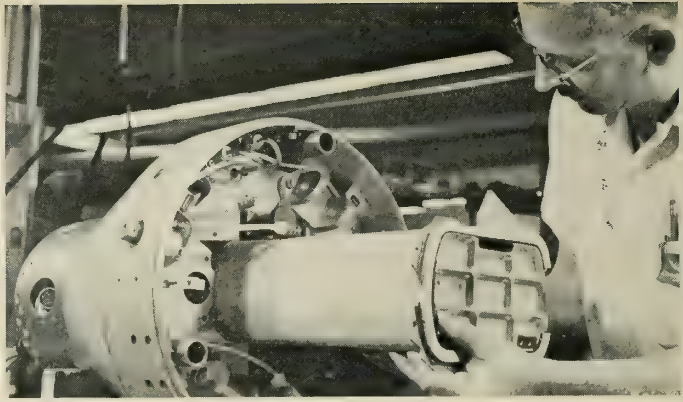
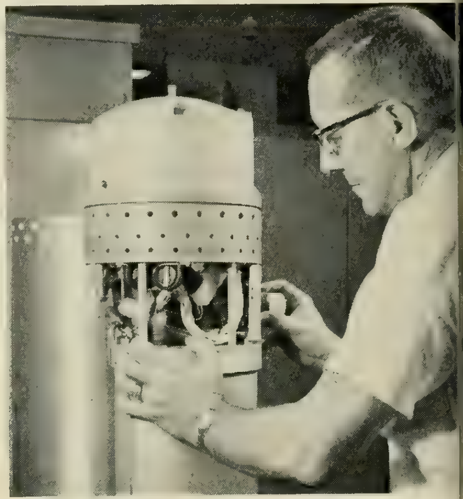


2

space systems

ADDPEP Parachute Shot Due

1—Nose cones for two ADDPEP test missiles are given final touches at Goodyear Aerospace experimental laboratory. 2—Container to hold final recovery during first phase of flight is inserted into aft of missile, which also contains two monitoring cameras. 3—Telemetry equipment is checked by manufacturing coordinator. Rocket case to cover equipment is at left rear. 4—Lanyards to hold brake flaps erect for booster separation are fastened by a Goodyear Aerospace technician. 5—Brake flaps for decelerating Nike rocket after separation are tested. Parachute goes in light-colored structure.



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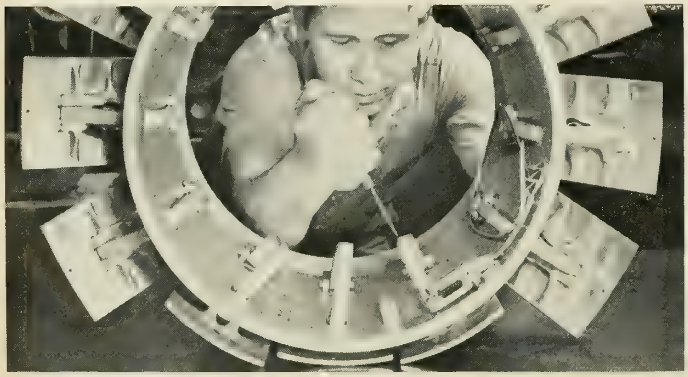

4

EGLIN AFB, FLA.—First of a series of missile firings to test parachutes and balloon-type deceleration devices for re-entry vehicles traveling at speeds as high as Mach 10 is slated to take place here early this week.

A new missile dubbed *ADDPEP* (for Aerodynamic Deployable Decelerator Performance Evaluation Program), developed and produced by Goodyear Aerospace Corp. (see cover), was scheduled to be boosted by two *Nike* rockets to 100,000-ft. altitude. When the vehicle reaches Mach 2.2, a 4-ft.-dia. parachute deploys to slow and stabilize descent speed.

Ten flight tests are planned during the *ADDPEP* program, part of what the company calls "the most intensive study ever made of deceleration and stabilization systems for advanced re-entry objects." The work is funded under a contract of over $1 million from the Research and Technology Division, Air Force Systems Command, Wright-Patterson AFB, Ohio.

The company is developing its Ballute (balloon-parachute) decelerator device for emergency ejection of astronauts in Project *Gemini*. Ballute's decelerator and stabilizer will be tested during *ADDPEP* at much greater speeds and altitudes than those involved in *Gemini*. ■

5

Aerospace Oriented Scientists & Engineers

Investigate new opportunities in Electronics offered by the United States Air Force in

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The AIR FORCE SYSTEMS COMMAND and AIR FORCE LOGISTICS COMMAND offer electronics career opportunities at strategic locations throughout the United States, where you can make direct, meaningful contributions to the nation's most vital and challenging aerospace programs. Activities of these major commands of the UNITED STATES AIR FORCE are located in 22 key areas, and assignments are available in diverse areas such as Range Instrumentation, Missile Instrumentation, Space Navigation, Instrument Calibration, Design and Development. Immediate openings are available for Electrical, Electronic and Mechanical Engineers with Bachelor's, Masters's or Ph.D. degrees and experience in the following:

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To evaluate Range Contractor instrumentation proposals designed to meet test requirements by using telemetering means which include HF, VHF, UHF transmission and receiving equipment, complex antenna systems, recording systems.

ELECTRONIC ENGINEERS (CALIBRATION)

Will perform a variety of engineering projects relative to precision measurement and calibration problems, theories and procedures involving missile and aircraft weapon systems.

ELECTRONIC ENGINEER (INSTRUMENTATION)

To evaluate foreign scientific and technical capabilities in diverse aerospace electronic instrumentation applications.

INSTRUMENTATION ENGINEER

To study, plan, design and monitor development and fabrication of instrumentation components and systems in connection with flight testing.

ELECTRONIC ENGINEER (INDUSTRIAL)

Provides AF Quality Assurance Representative with capability to cope with Quality Assurance engineering problems. Participates in review and evaluation of Contractor's Reliability Assurance Program. Evaluates statistical testing plans; verifies validity of test data.

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DataTape
DataTape
VR 3300
CEC

Smooth working team

Both have an eye on the budget

CEC's VR-2800 (general lab) and VR-3300 (portable) form an efficient team within CEC's complete and advanced line of recorder/reproducers. They are comparable solid state systems having interchangeable plug-in electronics, delivering high quality performance at relatively low cost. They can be used to complement one another in many applications.

Both instruments record 100 kc data at one-half conventional speeds. Thus, recording time of a single reel is doubled. They are currently serving on many critical military, lab, shipboard and van assignments.

Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0 to 20 kc with wideband FM techniques. IRIG PDM electronics are also offered.

Single cabinets of the VR-2800 and VR-3300 contain full 14-channel record and reproduce systems. Six standard speeds in three pairs (60, 30 ips; 15, 7½ ips; and 3¾, 1⅞ ips) are set by means of a simple belt and switch change. Both systems feature solid state electronics for reliability and low power consumption.

Other features include: all-metal-surfac magnetic heads, automatic end-of-reel stop and backlighted mode controls.

For complete information and specifi cations, call your nearby CEC office, o write for Bulletins CEC 2800-X16 an 3300-X16.

Data Recorders Division CEC

CONSOLIDATED ELECTRODYNAMIC

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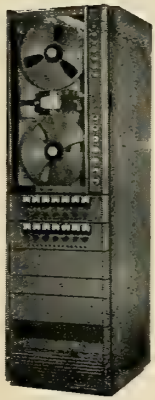
TWO MORE WAYS

CEC reflects the state-of-the-art in instrumentation record/reproduce magnetic tape systems

VR-2600



VR-3600

For extra wide bandwidth, consider CEC's VR-2600 with 7- or 14-channels. Handles precision data from 400 cps to 600 kc, Direct; d-c to 80 kc, FM; IRIG PDM and PCM at 1000 bits/inch on each of 16 parallel tracks via saturation techniques.

CEC's VR-3600 is the first 1.5 mc recorder sold to working specifications. Has linear phase vs. frequency characteristics, 7- or 14-channels, six pushbutton selectable tape speeds. Call or write CEC for Bulletins 2600-X30 and 3600-X22.

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Circle No. 7 on Subscriber Service Card

space medicine

Prolonged Spaceflight Poses Monotony Problem

Aberrations of one-man tests absent in two-man trials; subjects fight boredom by reading, reminiscence, fantasy

by Heather M. David

BOREDOM, INTERPERSONAL relations and work-rest cycles loom as the biggest psychological problem areas for prolonged spaceflight, the Air Force has concluded after logging more than 3,800 hours in simulated space.

Sensory deprivation, isolation, and confinement did not cause the problems some psychologists had expected, as long as there were two men in the crew. Capt. Earl H. Cramer and Lt. Col. Don E. Flinn of the School of Aerospace Medicine's Neuropsychiatry Department said in an Air Force report that while subjects in previous one-man simulator studies experienced aberrations severe enough to end their tests, there were no such problems with two-man crews.

The Air Force report affords some of the best literature to date on spaceflight psychological reactions. While weightlessness and threat to life present in actual space cannot be simulated, the tasks and environment were designed to give a good idea of what future space crews face.

While no stresses were programmed in, several accidental fires in the cabin reminded the subjects that some risk was present. In one case, the two crew members were dragged unconscious from a flaming cabin.

The Air Force observations were made during environmental studies in two 30-day simulated flights at 18,000 ft., four 17-day flights at 33,500 ft. and two 17-day control flights at ground level pressures. The crews were not matched psychologically, although they were extensively examined by psychiatrists and psychologists prior to the tests. During the tests they completed a number of psychological tasks, and were observed continually through one-way windows.

• **Monotony chief problem**—The most significant psychological threat to successful flight was the problem of monotony while on duty, the AF doctors reported. Subjects reacted to this boredom in three ways: they either indulged in reminiscence and fantasy; read; or became drowsy.

The doctors questioned that anything could or should be done to artificially stimulate the men for fear of distracting them from their jobs. If nothing can be done, they add, it might best take the form of exploiting fantasy, since this condition is closest to attentiveness. They suggest that individuals "who must retreat from anxiety-producing fantasies by means of drowsi-

Oxygen Test Begun

The longest known experiment exposing humans to 100% oxygen at a simulated 27,500-ft. altitude began Nov. 4 at the School of Aerospace Medicine, Brooks AFB, Tex. Four Air Force enlisted men will be confined for a total of 42 days in a study jointly funded by the AF Aerospace Medical Division and NASA's Manned Spacecraft Center.

During the first week, the subjects were in a sea-level environment while baseline studies are made. After a nitrogen flushing period, the atmosphere will be changed to 100% oxygen for a duration of 30 days. After emergence and a half-day of X-rays, lung and eye examinations, the subjects will re-enter the capsule again at sea-level for 5 days of follow-up studies.

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ness or reading should be screened out." They also concluded that there is need for personally programmed diversionary activity.

Time usually passed slowly, the subjects reported, especially after work-rest routines were established. Clock-watching became a major occupation, and checking off time blocks appeared to help motivation. However, once out of the capsule, the men all reported that they thought the test had been only 1/2 to 2/3 its actual duration.

- **Heard things**—Sensory deprivation caused some perceptual distortions in at least half the subjects, but "these were transient and not associated with a true loss of contact with reality, nor with anxiety or disruption of performance." The distortions usually took the form of imagined music or other random noises, but the subjects were able to determine that they were imaginary.

- **Crew frictions**—All crews exhibited some degree of tension between members. This was regularly present in six different crews. The reactions were overtly suppressed, but "considerable hostile interaction took place." While the subjects did not show these feelings to one another, they did not hesitate to release this tension by making derogatory remarks about the control monitors, even though they knew they were being overheard.

The subjects also evidenced an attitude toward their monitors "akin to the clinical transference reaction," in which they regarded the monitors as "omnipotent and omniscient." If the ground monitors faltered, it caused resentment and anxiety.

This relationship between ground controllers and crew is significant, the doctors observed. The well-liked monitor created pleasure, while the disliked one caused irritation to a degree that might affect the crew's performance. In addition, crew members were reluctant to trust the judgment and efficiency of ground crews and their partners. Such reactions can be dangerous, the doctors pointed out, since it will be years before the space pilot can rely on his own judgment as he now does in aviation.

- **Sleep**—Crew members averaged about 10 days in adjusting to an activity schedule permitting sleep in 2 or 3-hour blocks, with a 5-hour stretch every 2 days. This sleep apparently was not as refreshing as normal sleep, and lowered ability to respond to unexpected demands. About half the subjects noticed that they were able to fall asleep much quicker than before, and two noticed a reduced need for sleep. Most became disoriented concerning day and night, and found it necessary to reorient themselves in some way. ■

ComSat Readies RFP's

Search for better travelling wave tubes expands; report from Lincoln Labs gives push to use of millimeter waves

by Michael Getler

BOSTON—The Communications Satellite Corp. within the next six weeks will request proposals for a detailed engineering design and cost study of both intermediate-altitude and synchronous-altitude ComSat configurations.

Separate RFP's will be issued for each of the two altitude categories. The studies will be of six months' duration, supported by ComSat Corp. funds. Parallel studies of each configuration will be carried out if more than one proposal shows promise.

Current plan, according to ComSat Corp. officials, is to let the design contracts early next year and have results in hand by the fall of 1964. Selection of a system which could meet an initial 1966 launch date and a 1967 operational date probably would be made in the last quarter of next year.

Speaking at a heavily-attended special management session at the Northeast Electronics Research and Engineering Meeting (NEREM) of the Institute of Electrical and Electronics Engineers here last week, ComSat Corp. engineering manager Sidney Metzger also revealed the critical attention the newly formed corporation is paying to operational problems and development possibilities of traveling-wave-tubes (TWT).

These tubes are certain to form the heart of active-repeater spaceborne transmitters for a considerable period until solid-state design advances into higher frequency and higher power categories. The TWT could also play a major part in ground transmitters.

As an example of the importance of TWT design to overall system, Metzger points out that raising efficiency of these devices from about 25 to 50% could cut satellite weight by one-third.

TWT design is also intermeshed in the multiple-access capabilities which, it is hoped, can be built into operational ComSat systems with sufficient scope to be economically useful.

- **TWT studies**—Within the next several weeks, three key studies being made for the corporation by Bell Telephone Labs, RCA and Hughes Aircraft Co. are expected to be completed.

BTL is performing a broad study to determine response of various TWT's under conditions in which multiple communications carriers in several combinations are put through them simultaneously.

RCA is making measurements with a new lithium ferrite limiter device, said to be of considerable interest to ComSat engineers. This essentially equalizes various channels of differing amplitude and frequency. RCA is attempting to examine behavior when several channnels are passed through.

Both the BTL and RCA studies are aimed primarily at multiple-access technology involved with intermediate-altitude satellites, wherein each ground station uses a different frequency, but all these go through a common TWT.

The Hughes study basically involves synchronous-altitude systems using a single-sideband, suppressed-carrier approach. Hughes is making tests, reportedly first of their kind, of a very-high-power (several kilowatts) ground-station SSB transmitter tube—possibly using a TWT with depressed collector—to generate several hundred channels.

In another move to broaden the base in TWT engineering, ComSat Corp. has sent letters to 16 top U.S. TWT manufacturers and six foreign concerns in an effort to determine not only what is now available, but what new equipment and application techniques are on the way.

Metzger, sitting in for ComSat Corp. President Joseph V. Charyk, took part in one of the most high-powered semi-technical sessions ever to grace an annual engineering conference. With Metzger were Rear Adm. I. J. Galantin, chief of the Navy's Special Projects Office; Dr. Joseph Shea, manager of NASA's *Apollo* spacecraft program; and Maj. Gen. C. H. Terhune, Jr., chief of the AF Electronic Systems Command at Hanscom Field.

- **Millimeter wavelengths**—Support is growing for use of millimeter wavelengths for a wide range of aerospace communications and tracking functions.

An assessment of the current or soon-to-be-at-hand state of the art in this somewhat controversial technology, presented at NEREM by scientists at MIT's Lincoln Laboratories, indicates increasing potential for these wave-

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lengths and a corresponding increase in the options now available to advanced radar design engineers.

Growth in the use of millimeters has been impeded primarily by the lack of a major customer or stated requirement for systems operating in this region, despite the fact that there is widespread study of their possibilities and some degree of support for their use within both government and industry.

Severe limitations in the terrestrial environment for millimeter devices also has hampered component and technique development.

Proponents say that many of the basic gains of optical systems, such as increased bandwidth, narrower beamwidth with the attendant security, and smaller componentry—including smaller high-gain satellite antennas—can be achieved with use of millimeters without requiring the totally new technology embodied in optical systems.

Lincoln Lab scientists said millimeter systems with the following characteristics have been demonstrated experimentally or are anticipated, with fair certainty, in the near future:

—Antenna gains in excess of 72 db and probably reaching 75 db.

—Power generation of over 1,000 watts at 8 mm (about 35 gc) and over 100 watts at 3 mm (95 gc).

—Pulsed power at 8 mm of 200-kw peak and 100-watt peak average. A 3-mm tube has operated at 100-kw peak and over 300-watt average power.

—Maser amplification at 3 mm and longer wavelengths.

—Relatively low noise—order of 10 db noise figure—TWT amplification with the wide bandwidths at both 3 and 8 mm.

—Parametric amplification at 8 mm.

To enhance component development in this area and provide a testing facility, Lincoln Labs initiated a program for construction of a long-range millimeter radar capable of observing reflections from the lunar surface. Initial phase of the program has been completed and successfully tested.

The Lincoln antenna is a 28-ft.-dia. paraboloid with a measured gain of 67.5 db and a beamwidth of 4.3 minutes of arc, or one-seventh lunar diameter.

In addition to the high antenna performance, scientists at the lab cite the combined frequency stability of the transmitter and local oscillator (less than 100 cps over the 2.5-sec. round-trip lunar transit time) and the low transmitter power (12 watts peak power) used in the system.

Scientists consider the lab's 28-ft. dish probably "the most thoroughly evaluated 8-mm dish in the world." The Soviets are known to have a 72-ft. dish designed to operate at 8 mm with a gain estimated at around 72 db. ■

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Instrumentation Engineer To specifiy and define in detail techniques for measurements on solid rocket motors, to design electronic or solid state circuitry as required, and to coordinate instrumentation program, including electronic construction, laboratory work and standards. BS in EE, AE or Physics preferred, with 3 years experience with recording instrumentation for solid rocket motors.

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Product Processing Manager To supervise and direct the processing or production of propellant, and the manufacturing assembly of rocket propulsion products as well as to investigate and evaluate new types of processing equipment and techniques for processing high energy propellant. BS or MS in technical field, knowledgeable in process development, design planning, inspection and procurement methods, with 5-10 years experience in the missile/space industry in manufacturing assembly operations and in solid propellant processing, propellant formulations and properties.

Process Engineering Group Leader To direct preparation of specifications, plans and schedules for processing operations and to direct processing of propellant formulation and motor components for use in rocket motor development or production programs. BS or MS in ChE or Chemistry with 5-10 years experience in the missile/space industry involving solid propellant processing and motor assembly.

DESIGN & DEVELOPMENT

Senior Propellant Chemist To formulate, develop and tailor solid propellant fuels of any process type to meet design performance requirements of new, novel or special application rocket motors, as well as to make recommendations for advanced design fuel systems, and development of new ignition systems, gas generator charges and hybrid combustion systems. Minimum BS in Chemistry or Physics, with 5-10 years experience in the solid rocket propulsion field, preferably with first-hand knowledge of high energy fuel formulations, tailoring, testing and evaluation.

Structural Design Engineer To supervise design of structural components for rocket motors and associated equipment; specify materials and recommend methods for construction of designed items; and to calculate stresses, strains, heat transfer, vibration and dynamic loading effects. BS or MS in ME with 3-6 years in design and analysis of solid propellant rocket structural components or associated equipment.

Ballistician To make preliminary ballistic designs, evaluation and analyses (including propellant grain and igniter), assist in ballistic development, generate test requests, analyze and evaluate test results, as well as to make preliminary charge design studies for proposals and ballistic calculations of the parameters on propulsion units. BS in Physics, ME or equivalent with 2-4 years experience in design, ballistic evaluation and analysis of solid propellant rocket motors.

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Engineering Spectaculars – Fact, not Fiction at Bell Aerosystems . . .

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SPACE SYSTEMS DEVELOPMENT ENGINEERS To determine requirements and advanced concepts for space vehicles and space propulsion systems through company-funded and contractual advanced design studies. Assignments will include the coordination of activities in the preparation of major proposals, being cognizant of technical approach, scheduling and cost aspects. Successful proposals offer the potential of appointment to technical direction or project engineering responsibilities. BS in Engineering required with advanced degree preferred, and 8 to 15 years experience in system engineering. **Salary to $18,800.**

RAMJET AERODYNAMICIST Technical specialist to perform aero-thermodynamic analyses and plan and conduct tests of ramjet engine systems. Should have experience in complete engine test as well as component systems such as controls. MS or equivalent in AE or ME plus 7 to 10 years applicable experience required. **Salary to $15,400.**

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PRELIMINARY DESIGN ENGINEER To conduct analytical and design studies in all areas of liquid propellant rocket engines and injector systems. To be responsible for conceptual design and supporting analysis for new rocket propulsion systems. Requires an advanced engineering degree plus 6 to 12 years related experience. **Salary to $18,800.**

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Mergers and Acquisitions

Curtiss-Wright Corp. has conceded failure in its efforts to acquire 700,000 shares of Garrett Corp. common stock at its offered price of $57 a share. CW did not reveal how many shares it did acquire, but merely that it was not the 47% it sought. Shares that were tendered to CW are being returned. . . . *Anticipated merger of American Bosch Arma and Altamil Corporations has been called off. Negotiations on the subject between the two firms were cancelled by mutual agreement.* . . . Litton Industries, Inc., and Clifton Precision Products Co., Inc., Philadelphia, have reached agreement in principal to Litton's acquisition of Clifton. Clifton makes space vehicle and electronics equipment. . . . *United Electro-Dynamics, Inc., Pasadena, Calif., plans to acquire the assets of Allied Research Assoc., Inc., Concord, Mass. UE designs, develops and manufactures telemetry equipment; AR performs research in many scientific fields, including subsystem development of missiles and satellites.*

New Firms and Divisions

Hewlett-Packard Co., Palo Alto, Calif., has completed a corporate reorganization whereby the Sanborn Co. of Waltham, Mass., a subsidiary, will become a division of the parent firm. . . . *Varian Associates, Palo Alto, Calif., has formed two new product divisions and an Instrument Group. The new divisions are Analytical Instruments and Recorder.* . . . Information Processing Systems, Inc., a broker and consultant in electrical data processing systems, has been formed in New York City.

ComSat Chairman Named

Sidney J. Weinberg, partner in the New York banking firm of Goldman, Sachs & Co., has been elected chairman of a six-man committee to study and make recommendations on the procedure to be followed in making the Communications Satellite Corp.'s first stock offering. The offering is likely to be made in early 1964.

International

Products and services of Linde A.G., Wiesbaden, Germany, are now being marketed for the U.S. chemical, nuclear and aerospace industries by Lotepro Corp., New York City. Linde is one of the few firms active in the entire scope of low temperature processing, including cryogenics. . . . *Vactric Control Equipment, Ltd., has installed a Telex System in its head office in Morden, Surrey, England. The firm has also opened a new office in Geneva, Switzerland, as part of an expansion of its Continental Div.* . . . Systron-Donner Corp., Concord, Calif., has signed an agreement with Rank Cintel, Ltd., London, manufacturer of electronic instrumentation. Rank will manufacture S-D's line of digital measuring instruments and market the equipment throughout most of Europe and the British Commonwealth countries. . . . *Huggins Laboratories, Inc., Sunnyvale, Calif., has named Microwave Systems of Scarborough, Ontario, as sales representative for Canada. MS will handle Huggins' line of traveling wave tubes, oscillators, pulse generators and other electronic equipment. It will also represent the Applied Systems Corp., a Huggins subsidiary, manufacturer of infrared temperature measurement/control equipment.*

In the Courts

Edgerton, Germeshausen & Grier, Inc., a Boston scientific firm, has filed a patent infringement suit claiming at least $25 million in damages against the Federal Government in the Washington, D.C., U.S. Court of Claims. The firm charges that the Army, Navy, Air Force and NASA contracted with companies for production of items covered by EG&G patents, including exploding bridge wire bolts used to separate missile stages. The complaint states that these items were developed and patented by EG&G without the help of Government time, materials or facilities, and that none of the patents resulted from work done under Government contract.

Industry Facilities

Unidynamics Div. of Universal Match Corp. has opened a new plant in Phoenix, Ariz., for the research, development and manufacture of chemically-actuated devices and systems for defense and missile/space industries. The 70,000-sq.-ft. facility is designed for ease of expansion. . . . *Signetics Corp., Sunnyvale, Calif., developer and manufacturer of semiconductor integrated circuits, has acquired a 14,000-sq.-ft. building in Mountain View, Calif. The new facility will house research and manufacturing activities.* . . . Aircraft Porous Media, a subsidiary of Pall Corp., Glen Cove, N.Y., has opened a West Coast filter maintenance and engineering center for servicing precision filters used aboard space vehicles. The center is located at the plant of Mectron Industries, Inc., South El Monte, Calif. Pall is a manufacturer of airborne filters. . . . *Radio Corp. of America has announced plans to construct a $2.5-million plant in Camden, N.J. The 200,000-sq.-ft. plant will house the RCA Parts and Accessories activity.*

Company Representatives

Ucinite Co., Newtonville, Mass., has named Alisco Co., Chicago, as exclusive distributor for its line of electro-mechanical assemblies in Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska and northern Illinois. . . . *Polara Corp., Long Island, N.Y., electronic manufacturer, has appointed Crane & Egert Corp. sales representative in metropolitan New York, New Jersey and eastern Pennsylvania.*

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contracts

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$6,900,000—**Aerojet-General Corp.,** Sacramento, Calif., for field tests of parts for *Titan II* ICBM's.

$6,500,000—**Martin Marietta Corp.,** Baltimore, for continued research and development work on the *Titan II* booster for *Gemini* space flights.

$5,500,000—**Sperry Rand Corp., Univac Div.,** St. Paul, Minn., for nine computing systems.

$4,900,000—**Blount Brothers Corp.,** Montgomery, Ala., for construction of a research facility.

$4,000,000—**International Telephone and Telegraph Corp.,** Paramus, N.J., for a study of systems engineering.

$4,000,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for continued work on the *Minuteman* ICBM program.

$3,300,000—**Thiokol Chemical Corp.,** Bristol, Pa., for solid-propellant motor research and development work. Work to be performed at Brunswick, Ga., and Huntsville, Ala.

$3,000,000—**Sylvania Electric Products, Inc.,** Watham, Mass., for *Minuteman* test site equipment to be located at Vandenberg AFB, Calif.

$1,900,000—**Western Electric Co.,** New York City, for work on an early warning system for ballistic missiles.

$1,500,000—**Sperry Rand Corp., Sperry Gyroscope Div.,** Great Neck, N.Y., for follow-on contract to conduct a feasibility flight test program for electronics equipment related to missile systems.

$1,400,000—**Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for parts of *Agena* missile boosters.

$1,300,000—**General Dynamics Corp.,** San Diego, for continued work on the *Atlas* missile program.

$1,200,000—**Collins Radio Co.,** Dallas, for further work on a classified project.

$1,000,000—**Stelma, Inc.,** Stamford, Conn., for engineering, fabrication and installation of a communications control system.

$97,500—**Perkin-Elmer Corp.,** Norwalk, Conn., for a scanned laser display technique study.

Computer Associates, Inc., Wakefield, Mass., for development of the CL-11 programming system (undisclosed amount).

General Dynamics/Astronautics, San Diego, for *Atlas* space launch vehicles (undisclosed amount).

Computer Control Co., Inc., Framingham, Mass., for studies on theoretical and experimental investigation of techniques applicable to high sensitivity correlation radar systems (undisclosed amount).

ARMY

$13,500,000—**Martin Co.,** Orlando, Fla., for additional production of *Pershing* missiles.

$9,900,000—**Western Electric Co.,** New York City, for production and engineering services related to the *Nike-Hercules* missile system. Work will be performed at WECO; Bell Telephone Labs, Burlington, N.C.; Douglas Aircraft Co., Charlotte, N.C., and General Electric Co., Syracuse, N.Y.

$3,900,000—**Radio Corp. of America,** Camden N.J., for work on missile test systems.

$3,600,000—**General Precision, Inc.,** Clifton, N.J. for *Pershing* missile equipment.

$3,400,000—**Aerojet-General Corp.,** Sacramento Calif., for *Hawk* missile motor loading.

$2,900,000—**General Dynamics Corp.,** Pomon Div., Calif., for further work on the *Redey* missile.

$2,700,000—**Raytheon Co.,** Bedford, Mass., fo design and development related to the *Haw* anti-tactical ballistic missile system.

$2,500,000—**Belock Instrument Co.,** College Point N.Y., for 12 *Hawk* missile trainers.

$2,200,000—**Belock Instrument Co.,** College Point N.Y., for engineering services related to *Haw* missile training devices.

$1,600,000—**Western Electric Co.,** New Yor City, for further work on the *Nike-Hercule* missile.

$1,500,000—**Hawker Siddeley,** Toronto, Canada for development of a lightweight launcher t be used with the new *Lance* ballistic missil system. Firm was selected by the U.S. Arm and will be funded by Canada under a join effort.

$1,100,000—**Hicks Corp.,** Asheville, N.C., fo components for the *Nike-Hercules* missile.

$1,000,000—**Bendix Corp.,** Baltimore, for electronics equipment.

$627,529—**Douglas Aircraft Co.,** Santa Monica for field technician services for *Nike* technical assistance requirements from Oct. 1 1963 through June 30, 1964 (two contracts).

$134,865—**Western Eelectric Co.,** New York City for *Nike* missile system repair parts (tw contracts).

NAVY

$4,600,000—**Westinghouse Electric Corp.,** Sunnyvale, Calif., for *Polaris* missile launcher systems and spare parts.

$2,300,000—**General Precision, Inc.,** Glendale Calif., for continued work on the *Asro* missile fire-control system.

$1,500,000—**Northrop Corp.,** Anaheim, Calif. for *Polaris* missile checkout equipment.

$1,500,000—**Bendix Corp., Mishawaka Div.,** Ind. for further work on the medium-range *Typho* missile.

$1,500,000—**Lockheed Missiles & Space Co.** Sunnyvale, Calif., for engineering planning an support of the *Polaris* missile facility unde construction at Bangor, Wash.

$95,000—**North American Aviation, Inc.,** Lo Angeles, for a study of chemical pumps a high-energy sources for lasers.

NASA

$2,200,000—**General Dynamics/Convair,** Sa Diego, for two more *Little Joe II* launch vehicles which will be used in a 60,000-ft. altitude abort test.

$1,595,000—**Radiation, Inc.,** Melbourne, Fla., fo provision of additional command equipmen to be installed in the Mission Control Center at Clearlake, Tex., Houston, and Cape Canav eral.

$300,000—**Space Ordnance Systems, Inc.,** El Segundo, Calif., for provision of a series of ordnance devices for the *Apollo* spacecraft.

155,000—**California Computer Products, Inc.,** Anaheim, for production of an infrared scanning system for the *Tiros* and experimental *Nimbus* weather satellites.

99,000—**North American Aviation, Inc.,** Los Angeles, for development of new materials for *Saturn* rocket fuel tanks.

95,100—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for development of a micrometeoroid sampling instrument.

merson Electric Manufacturing Co., Electronics and Space Div., St. Louis, for development of a guidance checkout instrument for the *Saturn* booster system (undisclosed amount).

INDUSTRY

9,400,000—**Marquardt Corp.,** Van Nuys, Calif., from **North American Aviation, Inc.,** for development and construction of reaction control engines for the Project *Apollo* service module.

1,427,000—**Mosler Safe Co.,** Hamilton, Ohio, from the **Boeing Co.,** for ventilation valves for manned underground launch control capsules at *Minuteman* missile sitese.

690,000—**Alcoa's Rome Cable Div.,** Los Angeles, from **North American Aviation, Inc.,** for *Minuteman* nozzle control unit (NCU) cable assemblies.

400,000—**Beckman Instruments, Inc.,** Fullerton, Calif, from **Lear Siegler, Inc.,** for data-acquisition equipment to monitor static test firings of the *Saturn IV-B* stage.

304,000—**Frontier Refining Co.,** Denver, from the **Boeing Co.,** for services and supplies in connection with the *Minuteman* missile program.

177,615—**Powertron Corp.,** Plainview, N.Y., from **Martin-Denver,** for provision of ultrasonic propellant gaging sensors for the *Titan III* launch vehicle.

165,000—**Beckman and Whitley, Inc.,** San Carlos, Calif., from the **Boeing Co.,** for provision of equipment which would destroy unmanned *X-20 Dynasoar* spacecraft should they stray off course during test flights.

$162,000—**McCormick Selph Associates,** Holister, Calif., from **North American Aviation, Inc.,** for follow-on production of safe/arm initiators used in the ignition system of solid propellant rocket motors being produced for the *Sparrow III* air-to-air missile.

$130,000—**Garrett Corp., AiResearch Div.,** Phoenix, Ariz., from **Lockheed-Georgia Co.,** for test stands.

$111,154—**North American Aviation, Inc.,** Columbus, Ohio, division, from **Grumman Aircraft Engineering Corp.,** for construction and installation of a g-seat dynamic flight simulator.

$100,000—**Veeder-Root, Inc.,** Hartford, Conn., from the **Boeing Co.,** for elapsed time indicators.

$99,000—**Sun Electric Corp.,** Chicago, from the **Boeing Co.,** for provision of the hydraulic power supply for the *Dyna-Soar* spacecraft's acceleration rocket motor.

$90,732—**Thiokol Chemical Corp.,** Bristol, Pa., division from **Martin-Denver,** for manufacture of safe-and-arm devices for the *Titan III* space launch vehicle.

$83,000—**Los Angeles Standard Rubber Co.,** Los Angeles, from the **Boeing Co.,** for components used in connection with the *Minuteman* missile program.

Eitel-McCullough, Inc., San Carlos, Calif., from **Sandia Corp.,** for further development of a long-life, high-voltage battery, powered by nuclear energy (undisclosed amount).

HONEYWELL IN FLORIDA

Inertial Sensor Engineers

Investigate immediate career growth opportunities with HONEYWELL IN FLORIDA

Current in-house contracts at our Florida West Coast Aerospace Guidance/Navigation Center call for more top professionals to assist in solving the systems problems of the '70's. Assignments in a wide variety of disciplines and at every level of experience are now open. Among them:

INERTIAL SENSOR DESIGN AND ANALYSIS
Inertial Sensor Engineer (Senior) — BSEE, ME or Physics. Five years minimum experience in application, specification, test procedures and/or design and development of precision gyros and accelerometers for inertial navigation and guidance systems. Ability to analyze effect of gyro and accelerometer performance on system; plan test programs and interpret data to identify error sensitivity with respect to a variety of disturbance inputs (vibration, thermal gradients, magnetic fields, etc.); recommend design modifications necessary to obtain improved performance. Experience on gyros with gas-lubricated spin motors desirable. Should be capable of liaison with all levels of personnel in other departments associated with design, production, procurement, and use of inertial sensors.

INERTIAL SENSOR/INERTIAL COMPONENT
Design Engineer — BSME/EE. Three or more years experience in development and testing of gyros/accelerometers. Familiarity with electronic instrumentation techniques (including pulse circuits) and servo-mechanism practice. Knowledge of electromagnetic components, i.e., gyro torquers, pickoffs, etc.

Design Engineer — BSME. Three or more years experience in design of floated gyros/accelerometers for guidance applications. Familiarity with gyroscopic principals and applicable design analysis techniques. Able to design and conduct investigations pointed toward improving performance and producibility from a production standpoint. Knowledge of gas-bearing lubrication techniques desirable.

Many other immediate opportunities exist in associated disciplines so if you're "guidance oriented" we urge you to contact us at once.

QUALIFIED APPLICANTS ARE INVITED TO VISIT our facilities, meet our people and discover for themselves the many added advantages of working and living here on Florida's Suncoast. Simply send a brief note describing your education, experience and specific job interest to V. M. Keese, Honeywell, 13350 U. S. Highway 19, St. Petersburg, Florida. We promise a prompt, confidential reply.

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Honeywell facilities, send resume to F. F. Laing,
Honeywell, Minneapolis 8, Minn.

HONEYWELL ENGINEERS ARE DOING THINGS IN FLORIDA

Circle No. 10 on Subscriber Service Card

New Product of the Week:

High-Speed Actuator

An ultra-high-speed actuation system has been developed by Weston Hydraulics, Ltd., a Borg-Warner subsidiary.

Called TEMOS (Transient Electro-Magnetically Operated System), the unit is comparable to an all-electric actuator or a solenoid system except it eliminates drawbacks of these conventional controls while operating at speeds of faster than 1 millisecond to 800 microseconds. The unique operating principle of TEMOS features a bi-stable plunger which is rapidly accelerated in either direction by a lightly inductive coil. The coil is driven by a high-energy capacitor, discharged through the coil to create a large flux field and produce a transient magnetism of the plunger

Circle No. 225 on Subscriber Service Card

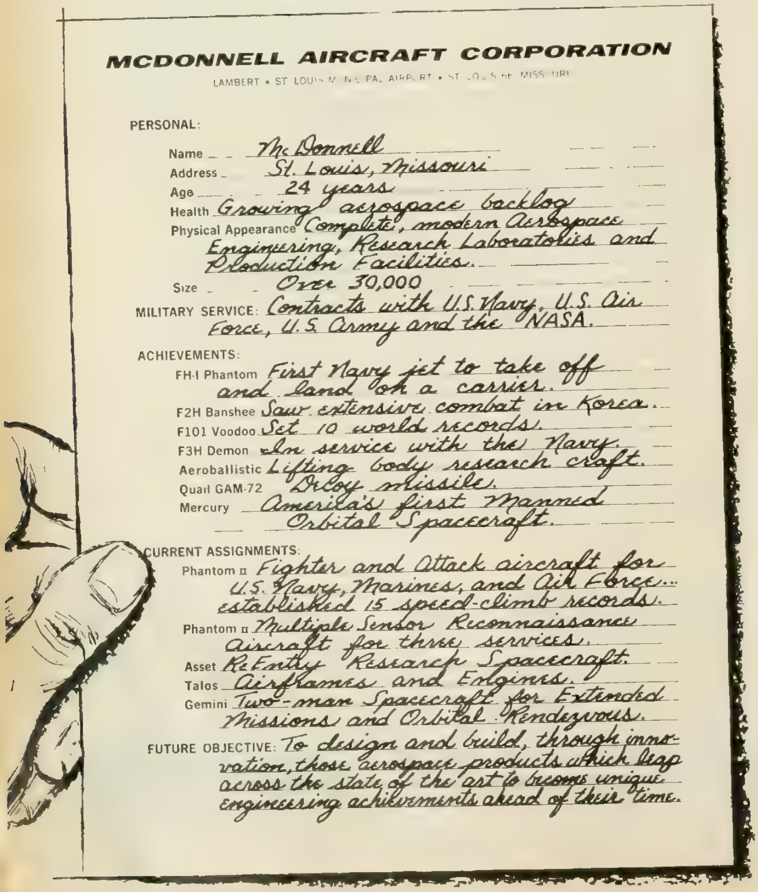
Components Oven

A components oven for sub-miniature circuits and temperature-sensitive electronic components has been developed by the Electronics Div. of Bulova Watch Co., Inc.

The Model COMT-175-7 has a temperature stability of 0.2°C at a fixed ambient and will hold within 3°C through a range of −55° to 10°C below the setting of the oven. Range is 25° to 100°C.

Internal volume of the oven is ⅓ cu. in. The unit has a 7-pin hook terminal header, but mounting and connector configurations can be modified per requirement. The thermostat permits operation of the oven for more than 20,000 hours.

Circle No. 226 on Subscriber Service Card



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Address St. Louis, Missouri

Age 24 years

Health Growing aerospace backlog

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Size Over 30,000

MILITARY SERVICE: Contracts with U.S. Navy, U.S. Air Force, U.S. Army and the NASA.

ACHIEVEMENTS:

FH-I Phantom First Navy jet to take off and land on a carrier.

F2H Banshee Saw extensive combat in Korea.

F101 Voodoo Set 10 world records.

F3H Demon In service with the Navy.

Aeroballistic Lifting body research craft.

Quail GAM-72 Decoy missile.

Mercury America's first Manned Orbital Spacecraft.

CURRENT ASSIGNMENTS:

Phantom II Fighter and Attack aircraft for U.S. Navy, Marines, and Air Force... established 15 speed-climb records.

Phantom II Multiple Sensor Reconnaissance aircraft for three services.

Asset ReEntry Research Spacecraft.

Talos Airframes and Engines.

Gemini Two-man Spacecraft for Extended Missions and Orbital Rendezvous.

FUTURE OBJECTIVE: To design and build, through innovation, those aerospace products which leap across the state of the art to become unique engineering achievements ahead of their time.

LET'

Vital programs in the national intere
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Department 62 **MM**, McDonnell, St. Lo
66, Missouri.

Sorption Hygrometer

Gilbert & Barker Manufacturing Co. is marketing a sorption hygrometer for measurement of moisture in gases and liquids. The device is based on detector made of specially coated uartz crystal.

The unit covers a range of less than to about 25,000 ppm (dew-points of ss than —100° to 70°F) with a single etector. Response speed for decreasing oisture from 1,000 to less than 10 ppm s 30 to 60 seconds. Reading is better han 90% of the final value.

The meter has a sample flow rate of 50 to 1,500 cc/minute and sample ressure of 0 to 100 psig. Accuracy and epeatability are both ±5% of full cale. Power input is 100 to 125v, 60 ps.

Circle No. 227 on Subscriber Service Card

elium-Xenon Laser

Raytheon Co. has developed a gas aser capable of penetrating atmospheric bsorption and optical interference.

The helium-xenon unit operates at wavelength of 3.51 microns from any 15v, 60 cps lighting circuit. The device nd its power supply measure 0.2 cu. t. and weigh less than 10 lbs. Voice ommunications are possible with an ptional modulator circuit that can be installed in the same case.

Output power is approximately 0.25 milliwatts. Divergence of the plane-polarized beam is 20 minutes of arc, uncollimated. Bandwidth is 110 megacycles. The 6-in. tube has Brewster windows. Configuration of the resonator cavity allows a 3-in. clearance for intracavity experiments.

Circle No. 228 on Subscriber Service Card

Telemetry System

Systems Div. of Beckman Instruments, Inc., is marketing a telemetry system, the Model 4400 Digital Decommutator for PAM and PDM signals.

The device accommodates up to 144 channels with an amplitude accuracy of 0.1%. The system is based on the building-block concept for flexibility and compatibility with other ground station equipment.

Circle No. 229 on Subscriber Service Card

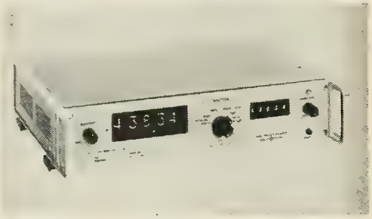
Air Compressor-Dehydrator

Eastern Industries has developed the Model PS-105 pressurization-dehydration system with a self-regenerating dehydrator unit that eliminates maintenance and replacement of the drying agent.

The device pumps air to two volumes of a waveguide system. Twenty SCIM is supplied continuously at pressures of 12 to 17 psig and 0.25 to 0.50 psig. Delivered air dew point ranges from 0° at 60°F to 15°F at 90°F ambient temperature. Operating temperature is from —40° to 150°F up to 100% relative humidity.

Circle No. 230 on Subscriber Service Card

Electronic Counter



The Model 5214L Preset Counter capable of direct measurements of gallons/second, RPM, kilograms/hour and other units of measure is available from Hewlett-Packard Co.

The device has an extra set of decades for controlling "gate open" time which may be preset to any integer from 0 to 100,000, making possible measurement of normalized ratio, time or rate. Basic counting rate is 2 cps to 300 kc.

Circle No. 231 on Subscriber Service Card

SWAP RESUMES

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Please complete this form and forward to: Mr. D. F. Waters, Professional Placement, Dept. 62, McDonnell Aircraft, St. Louis 66, Missouri. *This is not an application for employment.* Your qualifications will be reviewed by our placement staff and you will be advised of positions at McDonnell for which you qualify. You may then make application if you wish. All replies confidential.

Name________ Home Address________

City & State________ Phone________ Age________

Present Position________

Primary Experience Area________ Number of Years________

Education: AE____ ME____ Math____ Physics____ Chemistry____ EE____ Astronomy____ Other________

Degree: BS________ MS________ PHD________ I would like to receive application form ☐

Date Date Date

Openings now exist in the following areas:

Advanced Product Planning, Aerodynamics, Engineering Planning, Design, Control and Structural Dynamics, Electronics, Ground Support Equipment, Liaison, Materials, Mathematics, Metallurgy, Operations Analysis, Propulsion, Reliability, Research, Space Medicine, Structures, Systems Management, Thermodynamics, Wind Tunnel

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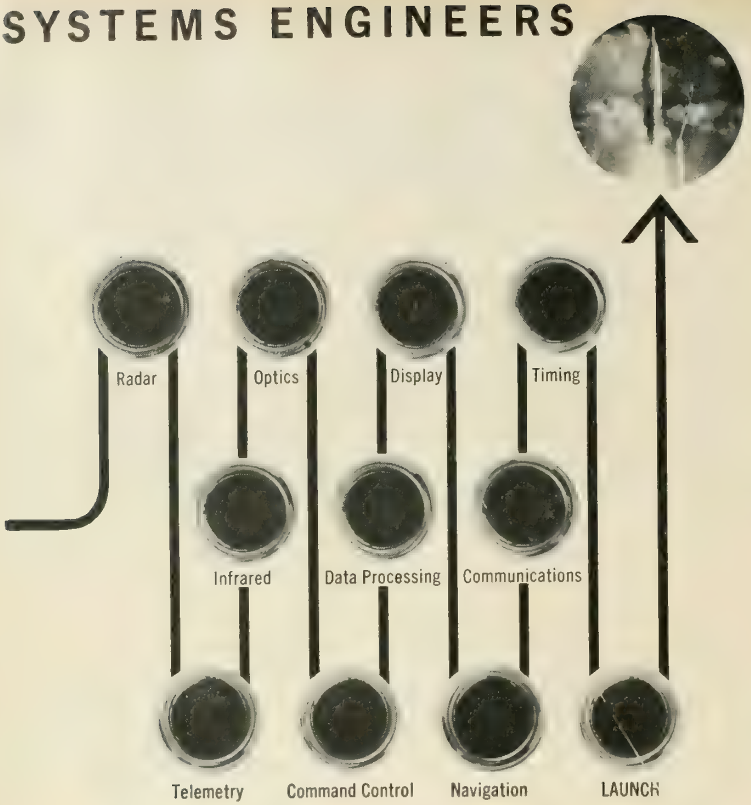
Circle No. 12 on Subscriber Service Card

SYSTEMS ENGINEERS



to reach "GO"

. . . vital decisions must be made between the drawing board concept of a range instrumentation system for a specific launch, and the final countdown at the Atlantic Missile Range.

The Systems Engineers of Pan Am's Guided Missiles Range Division are entrusted with these important assignments. They must develop systems studies for each new concept, prepare specifications, provide technical direction of contracted instrumentation for the Air Force, and phase it into operational status.

These varied programs encompass three major disciplines:

data acquisition, utilizing CW and pulse radar, optics, infrared, telemetry, and navigation.

data handling, including real-time transmission and computation, post-flight data processing, and data display.

data support, covering RFI, timing, command control and communications engineering.

Decision-making engineers with a minimum of 3 years applicable experience are invited to consider these important systems engineering positions.

For further information, write in confidence to Dr. Charles Carroll, Dept. **56L-2**

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Circle No. 18 on Subscriber Service Card

Hot-Air Gun

Kamweld Products Co. is marke ing a hot-air gun that provides a sourc of continuous, precisely controllabl forced air. The stream can be directe to a small area or to a number of area with output temperatures up to appro imately 900°F, at volumes from 2 t 8 cfm. Compressed air is heated insid a barrel. Heating elements are availab from 500 to 1,500 watts.

The unit can be installed singly c in groups. The gun has an air regul tor, pressure gauge and 5 ft. of 16/ cable. A 2-in.-long, ⅝-in.-dia. flange round tip and check-nut are supplie with each unit.

Circle No. 232 on Subscriber Service Card

Backward-Wave Oscillator

A line of 12 voltage-tunable bac ward-wave oscillators covering the 1 t 12.4-gc range has been developed b the Electron Tube Div. of Internation Telephone and Telegraph Corp.

The Series F-2500 has power ou puts ranging from 25 to 250 milliwatt Tubes are permanent-magnet focuse and various models use unifilar an bifilar helixes. Cooling is not require when the environment is below 60°C.

Input ranges from 250 to 1,000 Cathode currents are less than 25 mill amperes.

Circle No. 233 on Subscriber Service Card

Nitrogen Level Control

Johns & Frame Co. is marketing t SL-2E Automatic Control, a solid-sta sensor for positive electronic contr of LN_2 reservoir levels.

The device can be switched fro LN_2 to boiling water without dama and has a heat transfer of 0.05 wa while not in liquid. Line voltage is 11 ac, 60 cps. Power consumption is ne ligible. Level adjustment is unlimited.

The aluminum unit measures 6 x 5 4 in.

Circle No. 234 on Subscriber Service Card

Telemetering Indicator

Singer Co.'s Metrics Div. is ma keting the Panorami Telemetering In cator, the Model TMI-4/120.

The device covers the IRIG FM/F spectrum from 350 cps to 120 kc one second. It can be furnished handle channels to 190 kc. The u also provides adjustable linear scans any spectrum segment 100 to 20,0 cps wide. Automatic optimum reso tion is available for both modes. Sen tivity is 2 mv full scale.

Circle No. 235 on Subscriber Service Card

Frequency Changer

A 20-kva static frequency changer, capable of automatic paralleling, has been developed by the General Electric Co.'s Specialty Control Dept.

The unit converts 50-, 60- or poor quality 400-cycle power to precise 400-cycle power. Basic input is 120/208v; versions of the model can accept this or 40-v power. The device is rated for overload conditions up to 30 kva at .5 power factor.

Circle No. 236 on Subscriber Service Card

Elapsed Time Meter

Curtis Instruments, Inc., has available the Model 515-SE, a miniature milliampere hour meter measuring ⅜ x ⅜ : 1¾ in.

The unit has a full scale deflection of 10.4 milliampere hours and may be calibrated to indicate any time period rom 2 to 25,000 hours full scale. It s reversible by current reversal.

The meter meets MIL-M-7793C pecifications for vibration and shock. t is designed for operation at temperatures from −30° to 110°C.

Circle No. 237 on Subscriber Service Card

Tube Amplifiers

Raytheon Co.'s Microwave and Power Tube Div. is marketing two raveling wave tube amplifiers for use n broadband frequency diversity radar ystems.

The Models QKW574 and QKW-75 have a frequency range of 570 to 90 mc. Model 574 has peak power output rating of 3.0 kw and a 30-db gain. Pulse width is 8 μsec; peak current is .5 amps. Model 575 delivers a peak ower of 300 kw. Gain is 21 db, pulse width 7.5 μsecs, and peak current 50 mps.

Circle No. 238 on Subscriber Service Card

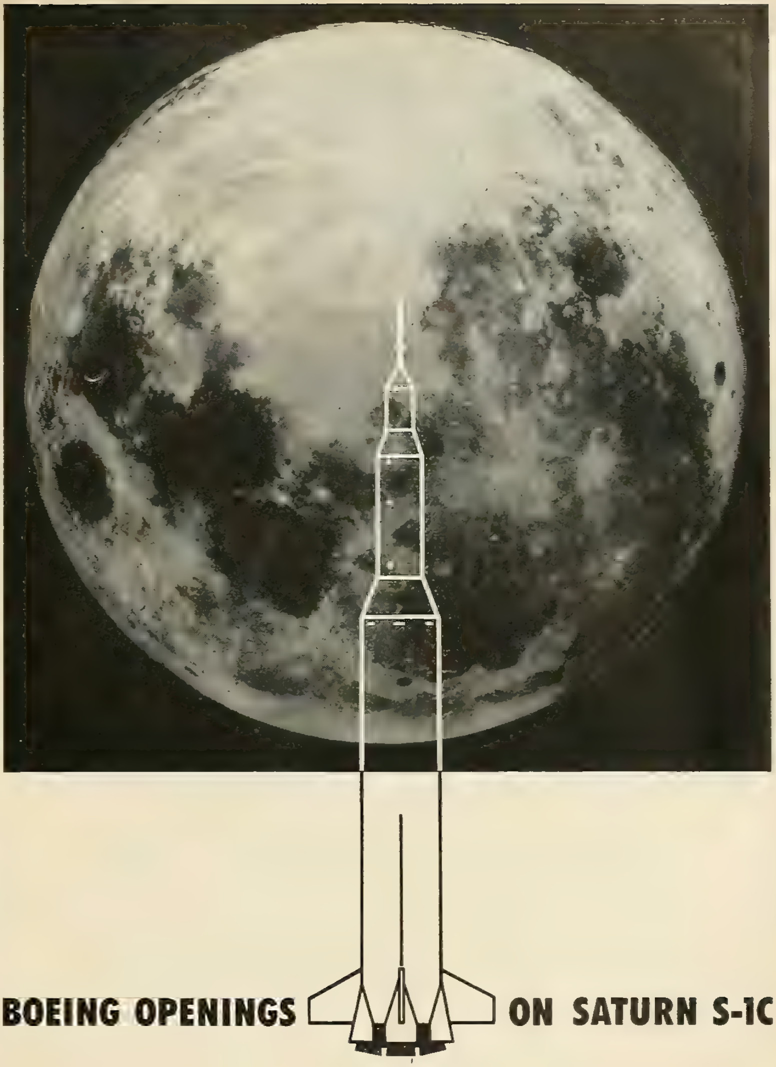
Communications System

Teletype Corp. has developed the alidata 100, a tape-to-tape, point-to-oint communications system with error etection and automatic correction.

The unit operates at 100 words per inute (10 characters per second) and ses an 8-level, 11.0-unit message and ata communications code.

The system can be adapted to transmit data over telephone lines. Both the ending and receiving terminals check iral parity after 72 characters have een processed. The receiving terminal lso can provide a vertical parity check ith optional components, if desired.

Circle No. 239 on Subscriber Service Card



BOEING OPENINGS ON SATURN S-1C

Boeing has primary developmental, building and test responsibility for NASA's S-1C Saturn V first-stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

This rapidly expanding program provides unique advancement advantages and ground-floor opportunities to physicists, mathematicians and engineers with the following specialties: electrical/electronics, propulsion, structural design, systems test, manufacturing, tooling, facilities, aerodynamics, cryogenics and high vacuum technology.

Salaries are commensurate with all levels of education and experience. Minimum requirement is a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly hired personnel.

Saturn assignments are in New Orleans as well as in Huntsville, Alabama. Other missile and space programs at Boeing's Aero-Space Division include the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle.

Send your resume to Mr. L. Wendell Hays, The Boeing Company, P. O. Box 26088 - MSR, New Orleans, Louisiana 70126. An equal opportunity employer.

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WOODCUT, C. 1515, OF MAN VIEWING OUTER SPACE

SOME 400 years ago, man's views concerning outer space were relatively simple—and obviously inaccurate. Today's space advances require an ever-increasing understanding of the physical and operational environments of manned space flight.

If *you* understand the environments of space vehicles and your background includes: guidance, navigation, celestial mechanics, flight control, attitude control, or space data processing and communications, you are invited to investigate the many career opportunities available at IBM.

The IBM Space Guidance Center, as guidance system integrator for the Gemini program, is developing the Gemini computer as well as improved docking/retrieving and re-entry techniques for NASA. The Center is also developing the guidance computer and related equipment for the Saturn program. IBM's on-board data processor for the Orbiting Astronomical Observatory is further evidence of the professional level of accomplishment by our space technology scientists and engineers.

Current studies at the IBM Space Guidance Center—in central New York State, bordering on the Finger Lakes vacationland area—include re-entry guidance and control, and space station data management and communications. IBM is an Equal Opportunity Employer.

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Manager of Employment, Dept. 604 L 2.
IBM Space Guidance Center
Owego, New York

IBM. FEDERAL SYSTEMS DIVISION
SPACE GUIDANCE CENTER

Linear Pulse Amplifier

Pearson Electronics, Inc., is marketing the Model 453 amplifier fo linear amplification of arbitrarily shape or square pulse voltages. The devic handles outputs up to 5,000v, either o both polarities, floatable to 45 kc dc.

A typical square pulse can hav 5,000v output at 20 μsec, 0.6 μsec ris and fall, 0.1% droop per μsec, duty c 0.1, into a 100 pf load. Bias supply provides 0 to 6 output, also floatable a 45 kc dc.

Circle No. 240 on Subscriber Service Card

Frequency Multipliers

L P Associates, Inc., has develope the Model 1000 series of wideban varactor frequency multipliers. Spurious output response is typically 25 d below the signal level.

The Model 1000-2, driven by a S-band RF source, produces X-ban power between 8.5 and 9.6 gc. It ha 10% efficiency and 12% (fixed tuned bandwidth. Input signal is 100 milliwatts. Output is flat over the band t better than ±1 db. Narrow band versions are also available.

Circle No. 241 on Subscriber Service Card

Servo Amplifier

Kearfott Div. of General Precisio Aerospace is marketing a micro-bloc electronic control servo amplifier ¼ i in volume and capable of delivering watts of power. Temperature range −55° to 71°C.

Electrical specifications include: si nal frequency, 400 ±20 cps; voltag input 28v dc ±10%; power input, 1 watts maximum; voltage output, 40 nominal; gain stability over temperatu range, ±3 db.

Circle No. 242 on Subscriber Service Card

Optical Comparator

Optical comparators in 8-in. or 1 in. screen sizes are available from th Micro-Vu Corp. By programming th unit with the proper master template the part to be inspected, absolute a curacies can be maintained over 100 of the viewing screen.

Interchangeable 10x, 20x, 31¼x 40x chromatic, color-corrected lens are available as standard equipment.

Circle No. 243 on Subscriber Service Card

Instrument Face Plates

Precision Optics Div. of Penns vania Optical Co. has available a li of cathode ray tube face plates ar precision-polished optical "flats" ar windows.

The units are available in sizes fro 1 to 42 in. and can be fabricated fro any type of glass, including heat reflective, heat absorbing, infra-red or ultra-violet. If desired, special machining including precision bevelling of edges to tolerances of 0.001 in. can be supplied.

Circle No. 244 on Subscriber Service Card

Sample and Hold Unit

Adage, Inc., is marketing the Model SA3 sample and hold amplifier.

The device has a response time of less than 10 µsec to reach 0.01% of final value for full scale input step change. Aperture is 100 nanoseconds. It features 100-µsec recovery from overloads up to 1,000% full scale.

The unit has an input impedance of 10 ohms per volt ±0.01%. Output is ±5v inverted and output current is ±20 milliamperes. Gain accuracy in all ranges is ±0.02% ±10 ppm/°C.

Circle No. 245 on Subscriber Service Card

Balanced Mixer

A miniature X-Band balanced mixer, employing the "air-strip" concept of strip transmission, is being marketed by Micro-Radionics, Inc.

The Model S-F-MI-X-003-3910 covers the entire X-band and can be supplied with two waveguide-to-coaxial adapters for systems requiring waveguide inputs.

Specifications include: bandwidth—8.2 to 12.0 gc; maximum overall noise figure—10 db; IF frequency—60 ±5 mc; power 1 to 3 milliwatts.

Circle No. 246 on Subscriber Service Card

Inversion Transformer

North Atlantic Industries, Inc., has available the Model T-120 Precision Inversion Transformer, allowing ratio box measurement of negative ratios.

The device provides unity transformation ratio within 2.0 parts per million over two octaves. Phase shift is less than 50 microradians. It may be used to drive any ratio box at a maximum voltage of 350v across a frequency range of 50 cps to 10 kc. Input impedance is greater than 10 k from 350 cps to 2 kc in the no-load condition.

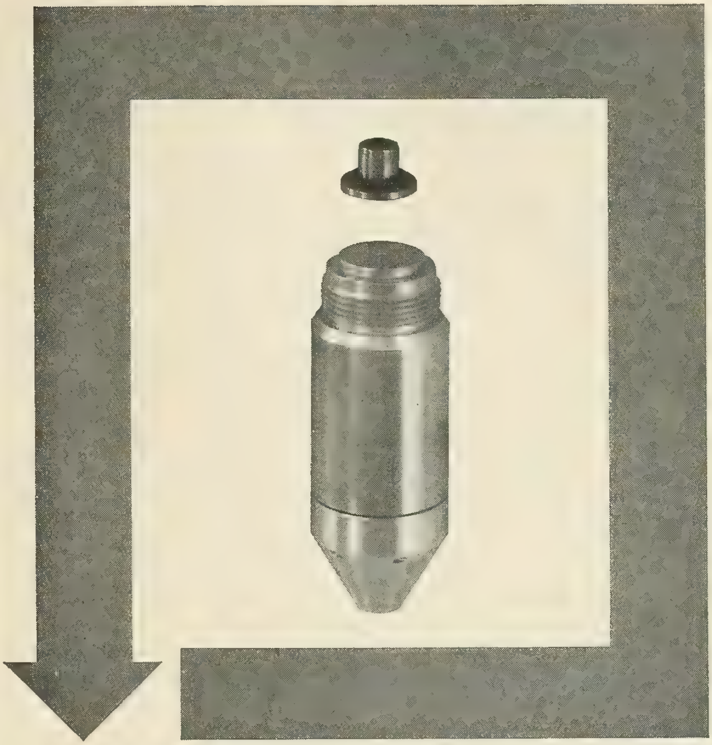
Circle No. 247 on Subscriber Service Card

Phase-Rotation Indicator

A phase-rotation indicator that shows the sequence of phases between polyphase circuits is being marketed by Western Electro-Mechanical Co., Inc.

The Model 4600 may be used interchangeably on any potential from 110 to 550v, at 25, 50 or 60 cps. Models are available for 400 and 1,000 cycles, higher voltages and panel mounting.

Circle No. 248 on Subscriber Service Card

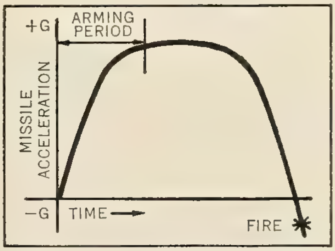


Keeps missiles from going off half-cocked

You'll **never** have to scrub a firing because of this safe/arm device—it's too simple to cause you any trouble! No wires, no power supply, no connectors, no cocked springs, and best of all, no susceptibility to RFI. You can kick it, cook it, magnetize it, and irradiate it, and it still won't do a thing until it's ready; when it **is** ready, the system is "go."

The Model 1029 safe/arm unit functions only from the acceleration profile of the bird which carries it, both arming and firing from inertial forces. It can be programmed to fire within a half a "g" of a selected value, and within 0.050 seconds of a required functioning time. It will initiate a percussion cartridge for ignition, stage separation, or destruct functions, or it may be used to operate a switch.

You need provide only about 3 cubic inches of space in the vehicle for the Model 1029, and allow for less than a pound of weight. And because it's all-mechanical, you won't have any problems with wires or insulation. May we give you some more of the details? Send us a note today.



Typical operating parameters: Arming period 2 seconds at 15 g acceleration; firing on reaching −2.5 g, ±0.5 g.

PELMEC
division of Quantic Industries, Inc.
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San Carlos, California

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—names in the news—

Anthony A. Anthony: Appointed district sales representative for Erie Technological Products, Inc., Erie, Pa.

Raymond H. Rice: Appointed to the board of directors of the H. I. Thompson Fiber Glass Co., Gardena, Calif.

David C. Sullivan: Appointed vice president and director of new markets development for the Guidance and Control Systems Div. of Litton Industries, Beverly Hills, Calif.

Dr. Louis G. Dunn: Appointed vice president and general manager of Aerojet-General Corp.'s Sacramento, Calif., plants.

John C. Cacheris: Appointed director of engineering of the Solid State Systems Div. of Motorola, Inc., Phoenix, Ariz.

Edmund Israel: Named manager of engineering by Industrial Electronic Engineers, Inc., Los Angeles.

Albert S. Takacs: Appointed vice president of operations at King Electronics, Inc., Pasadena, Calif.

William G. Miller: Elected chairman of the board of Alco Products, Inc., Schenectady, N.Y. **William F. Lewis** elected president.

Edward J. Rapetti: Appointed director of government marketing for the American Bosch Arma Corp., Garden City, N.Y. **Donald J. Lynch** appointed manager of the West Coast marketing office, El Segundo, Calif.

F. L. DuRant: Named sales manager of the Numerical Control Systems group of Thompson Ramo Wooldridge, Inc., Cleveland, Ohio.

Franklin W. Hobbs: Joined Antenna Systems, Inc., Manchester, N.H., as vice president-financial planning.

Nelson C. Smith: Appointed contracts manager for the Aerospace Div. of Walter Kidde & Co., Inc., Belleville, N.J.

Dr. Richard C. Lord: Professor of chemistry at MIT and director of its spectroscopy laboratory, named 1964 president of the Optical Society of America.

Richard J. Hanschen, Ronald F. Keener, Howard Moss and James R. Reese: Elected assistant vice presidents of Texas Instruments, Inc., Dallas.

Seymour Colman: Named manager of Beech Aircraft Corp.'s *Apollo* program Wichita, Kan.

Frederick J. Michel: Promoted to manager of the technical services division of Melpar, Inc., Falls Church, Va.

Robert G. MacEwan: Named director of engineering, Propulsion for Rocket Power, Inc., Mesa, Ariz.

M. G. Steele: Appointed director of sales and contracts for Remanco, Inc., Santa Monica, Calif.

A. V. Lesmez: Appointed advertising and sales promotion manager of Vacuum-Electronics Corp., Plainview, N.Y.

Joseph C. Ceva: Electric vice president-marketing for International Telephone and Telegraph Corp.'s Federal Electric Corp., Paramus, N.J. **Farar B. C. Martin** elected vice president and director of the Early Warning Systems Div.

Kenneth M. Carpenter: Joined Wyle Laboratories, El Segundo, Calif., as corporate controller.

Eugene E. Leist: Named base manager of Aerojet-General Corp.'s, Atlantic Missile Range Technical Services Office, Cape Canaveral.

Andrew S. Hazelton: Elected corporate controller of the Curtiss-Wright Corp., Wood-Ridge, N.J.

Dr. John Caffrey: Appointed head of the Special Development Dept.'s education project at System Development Corp., Santa Monica, Calif.

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CORRECTION—November 4 Ad Index
The advertising agency for **Allis Chalmers Mfg. Co.** should have been listed as **Klau-Van-Pieterson-Dunlap, Inc.**

—when and where—

NOVEMBER

Magnetism and Magnetic Materials Conference, sponsored by AIEE, IRE and AIP, Chalfonte-Haddon Hall Hotel, Atlantic City, N.J., Nov. 11-15.

Seventh Annual NMR-EPR Workshop, sponsored by Varian Associates, Palo Alto, Calif., Nov. 11-15.

Fall Joint Computer Conference, sponsored by IRE, AIEE, Association for Computing Machinery and American Federation of Information Processing Societies, Las Vegas Convention Center, Las Vegas, Nev., Nov. 12-14.

Seminar on Automatic Checkout Equipment and Techniques, sponsored by NASA's George C. Marshall Space Flight Center and Battelle Memorial Institute, Columbus, Ohio, Nov. 13-14.

American Society of Mechanical Engineers Winter Annual Meeting, Bellevue-Stratford Hotel, Philadelphia, Nov. 17-22.

Symposium on Unconventional Inertial Sensors, sponsored by Republic Aviation Corp., N.Y. Scientific and Technical Liaison Office, Air Force Systems Command's Research and Technology Div. and Bureau of Naval Weapons, Farmingdale, N.Y., Nov. 18-19 (classified).

Engineering in Medicine and Biology Conference, sponsored by AIEE, IRE and ISA, Lord Baltimore Hotel, Baltimore, Nov. 18-20.

Sixth National Symposium, Society of Aerospace Material and Process Engineers, Olympic Hotel, Seattle, Nov. 18-20.

Conference on Stratosphere-Metosphere Structure, sponsored by Texas Western College, American Meteorological Society and AIAA, El Paso, Tex., Nov. 19-21.

MAECON Symposium on Measurement and Instrumentation, sponsored by IEEE, Hotel Continental, Kansas City, Mo., Nov. 21.

DECEMBER

American Institute of Chemical Engineers Annual Meeting, Rice Hotel, Houston, Dec. 1-5.

33rd Symposium on Shock, Vibration and Associated Environments, U.S. Naval Research Laboratory, Washington, D.C., Dec. 3-5.

Testing of Manned Flight Systems Conference, sponsored by AIAA and NASA's Flight Research Center, Edwards AFB, Calif., Dec. 4-6.

IEEE Ultrasonic Engineering Symposium, Marriott Motor Hotel, Washington, D.C., Dec. 4-6.

IEEE 14th National Conference on Vehicular Communications, Adolphus Hotel, Dallas, Dec. 5-6.

IEEE Fourth Annual Seminar on the Reliability of Space Vehicles, Airport Marina Hotel, Los Angeles, Dec. 6.

AIAA Conference on Heterogeneous Combustion, Palm Beach, Fla., Dec. 11-13.

National Vendors Meeting, Space and Flight Equipment Association, San Diego Aerospace Museum, San Diego, Calif., Dec. 13-14.

Conference on Non-Linear Processes in the Ionosphere, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Dec. 16-17.

American Association for the Advancement of Science Annual Meeting, Cleveland, Dec. 30.

JANUARY

Tenth National Symposium on Reliability and Quality Control, Statler Hilton Hotel, Washington, D.C., Jan. 7-9.

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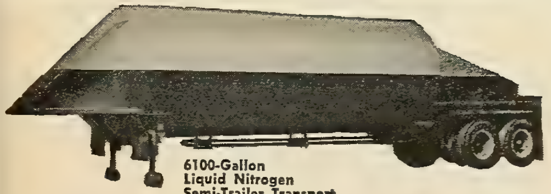

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Back to Sanity in Space

NOW THAT President Kennedy and Premier Khrushchev have confirmed that the United States and the Soviet Union both still are pressing ahead with their manned lunar programs, it is time to take a good look at just where the *Apollo* project stands.

President Kennedy has reaffirmed the Administration's intention to carry on with what he described as "our whole carefully worked-out program." We were pleased to note his emphasis that it is not just a question of going to the Moon but of having the competence to do so.

The President's strong and well-defined support for *Apollo* at his Oct. 31 press conference is most welcome to the industry. We hope it will be matched by the Congress in its budget decisions.

We also were glad to see Premier Khrushchev set the record straight with his declaration that the Soviet Union has not abandoned its manned lunar project and that he never said it had—a statement which left a great portion of the U.S. press looking silly, including a weekly aviation magazine which learnedly informed its readers that the temporary abandonment of the Soviet lunar program was a concession to anti-space factions pressing for greater fertilizer production.

But even though it is now clear that the Soviet Union still intends to launch its manned lunar expedition as soon as a safe return is certain, considerable confusion exists in regard to the U.S. space program.

Diverse and influential general publications not close to the industry, such as *Fortune* and *Aviation Week*, are calling for a reappraisal of the national space program. This echoes the sentiment of a highly vocal minority in Congress and in the scientific community.

Aviation Week states flatly on its editorial page: "New National Space Policy Needed," and supports this with an assertion that a fundamental reappraisal of what this nation can and should do in space is urgently needed.

Fortune had this to say in its November issue:

"The crash timetable should be abandoned in favor of one that places the Moon in perspective: i.e., as one way-station in the sequential development of space. . . . Such a revision of goals will, of course, bring a considerable outcry from those who have a large stake in *Apollo*—principally the NASA centers and the contractors—on grounds that a stretch-out will cost more in the long run. But it need not, given some judicious shifting of manpower to other projects, an end to the buildup of *Apollo's* overhead, and the obvious savings that will result from not having to do everything on a crash basis. . . . Once the distorting influence of *Apollo's* high priority is reduced, we could then redefine the goal of developing a broad capability in space."

We cannot emphasize too strongly that *Apollo* is not a crash program by any definition, and that *Apollo* itself offers the fastest avenue to development of a broad space capability and to sequential development of space. No reappraisal of national space policy, as demanded by these magazines, is necessary.

The present space policy is well thought out and properly oriented. What is needed is stronger emphasis on the portions of that policy which still need implementation or which need to be more clearly explained.

Congress and the Administration, having made Project *Apollo* the top-priority program of the National Aeronautics and Space Administration, should hold the space agency to that commitment. NASA Administrator James Webb should not be permitted to exploit the Congressional cut in funds as an excuse for delays and lack of financial support for *Apollo*. If funds are cut, then the cuts must be applied to programs other than *Apollo*.

Some members of the NASA community now are pressing for an expensive and separate manned space station program—basing their case on the fact that the Soviet Union may soon have one. Even aside from the fact that this argument continues the ridiculous practice of reacting to what the Soviets do, this activity should be brought to an immediate halt. NASA does not have the scientific and technical manpower to support another major program alongside *Apollo*, and the nation—and in particular, Congress—is in no mood to back a further major drain by NASA on the nation's economic resources.

ADMITTEDLY, there are desirable scientific goals which could be achieved by such a manned space station program. But these must await accomplishment of the *Apollo* objective, which will itself achieve many of them in its Earth-orbital activities.

If there is justification for a manned space station at this point in time, it is military. If the military can build a sound case for a manned space station, and we believe it can, then such a program should be funded as an Air Force project. The area of military space is one in which the national space policy needs to be further implemented.

But funding requests for research and development of such a space station under Air Force management should not be aimed at another multibillion-dollar project. It should be a far less expensive outgrowth of the technology being developed in the *Gemini* and *Apollo* programs. The programs should not be parallel, but complementary.

No reappraisal or reorientation of the national space program is necessary to carry out these tasks. This would only lead to further delays and uncertainties. With proper attention to military requirements, the Administration should continue on the orderly course on which it embarked two and a half years ago when President Kennedy established the goals.

William J. Coughlin

Systems Analysts & Preliminary Design Engineers for Advanced Space Guidance & Control Systems

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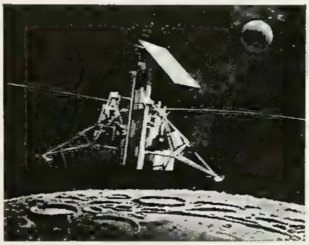

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NOVEMBER 18, 19

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HE WEEKLY OF SPACE SYSTEMS ENGINEERING

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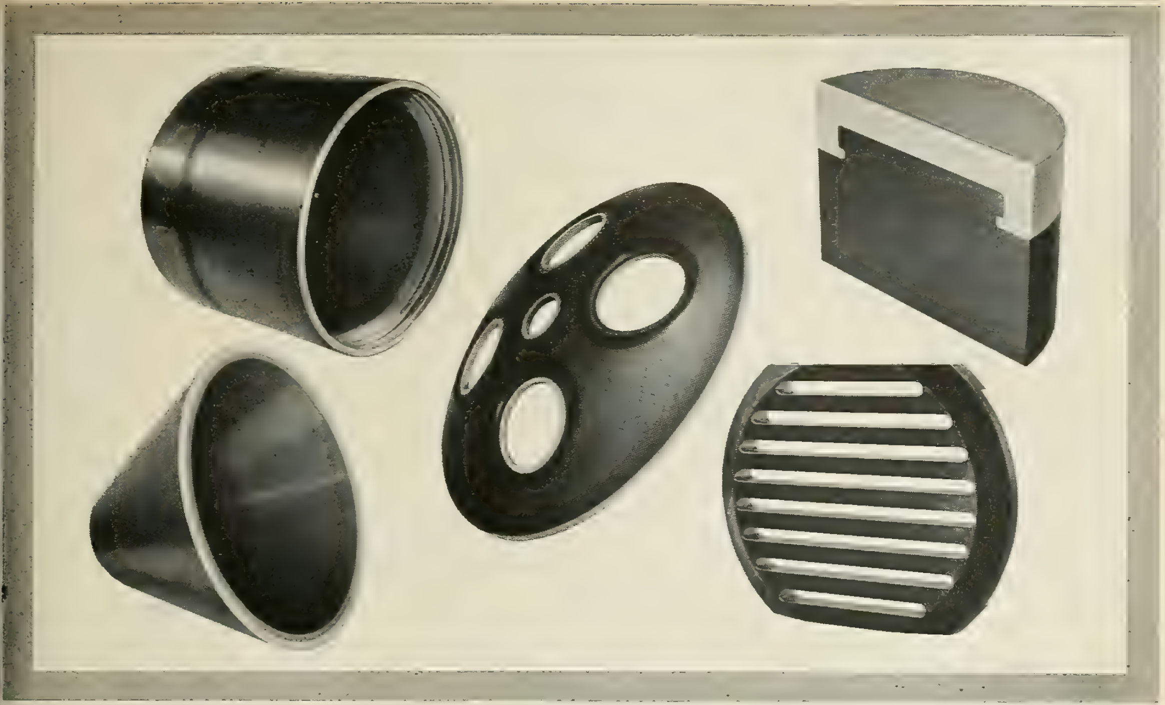

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Volume 13, Number 21 November 18, 1963

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THE COVER

Apollo "pad abort" vehicle lifts off in first test of Command Module's launch escape motor. Under development by Lockheed Propulsion Co., the solid motor will pull the Apollo module to a safe distance from its Saturn launch vehicle in case of launch phase malfunction. See "Shots of the Week," page 11.

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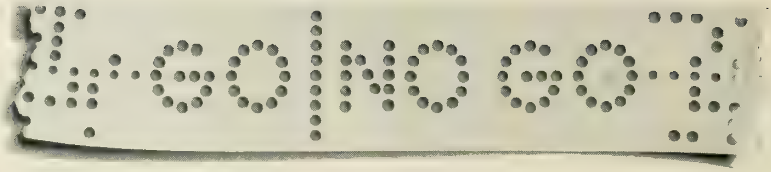
† U.S. Reg. Pdg.



DATA PROCESSING SYSTEMS FOR SPACE

Advanced STL digital telemetry units, decoders, and command distribution assemblies are now being used on NASA's OGO and Pioneer, and the Air Force's Nuclear Test Detection spacecraft. STL hardware and experience with on-board data processing equipment is being applied in the development of new systems which will perform checkout and maintenance functions in space. This advanced technology requires circuit designers, logic designers, and digital systems engineers. For Southern California or Cape Canaveral opportunities, write Professional Placement, One Space Park, Dept. B-11, Redondo Beach, California, or P.O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

TRW SPACE TECHNOLOGY LABORATORIES
THOMPSON RAMO WOOLDRIDGE INC.

Space Cooperation

o the Editor:

Maybe I am short-sighted, narrow-ninded or something, but I cannot have ny faith in a joint effort with the Soviet Jnion as far as the Space Program is conerned. The basis of my thinking is that ust as we must dominate the sea, the land, nd the air, we must dominate space for he future of our national security. It is my elief that the Communist bloc is the group bout which we are talking and I just canot have any faith in a joint program with his group.

You mentioned the Antarctic—and ver and over this project Antarctic is held p as an example of cooperation. I visited ne Antarctic and there we have our best ce-breakers, best airplanes, and nuclear eactors. We pay 95 cents out of every ollar that is spent for research in the ntarctic, then we make this information vailable to all nations involved there. I o not consider this a very good example f cooperation.

It might be that the joint lunar base rogram could work out, and maybe it's ood for the international scene to offer the roposal, but frankly, the President's statement at the United Nations has been the ardest blow against the Space Program as ar as Capitol Hill is concerned of anything hat has happened, and I believe next year will be almost impossible to secure the noney from Congress that will be needed carry this program on at a proper rate. believe that every time cooperation with ussia is mentioned, it will further hurt ne program.

Olin E. Teague
House of Representatives
House Committee on Science
and Astronautics
Washington, D.C.

Moon Program Scheduling

o the Editor:

As one who has been interested in space ghts since 1953—or a few years before ost of those now involved cared at all—t me toss in two cents of this controversy the scheduling for the Moon landing nd Khrushchev's role in it.

First, you exaggerated in your Nov. 4 litorial the reaction in Washington. Using e word "panic" seems excessive, for exnple. No other commentator on the capil situation thought it was anywhere near at. It *was* a large aid for the budgetutters, to get Khrushchev's remarks. And uch of the other reaction, I feel, came om leaders who had already felt a nanal tendency to slow down on *Apollo*. ow, they thought, they had more reason go along with that tendency. You are ite right, that the public is not sold on crash *Apollo* program; you are wrong insist that Congress fly in the face of blic opinion and push the crash sched- in spite of it. We are fortunate enough live in one of the few countries on Earth where the people's wishes do control their government. I would not change that for all the Moon bases or Mars bases you can think of, much as I too would like to see them established.

Second, your own quotes, on page 14, of Khrushchev's words tend to confirm that he is slowing down his own efforts. (Unless you choose to believe he was lying, in which case we must disregard completely what he says, and not use his words to support either side in the controversy.) He speaks of the U.S. planning a Moon landing in 1970-80; then he says "We shall take their experience into account"—which seems a pretty clear way to say that he will not land until after we do, for how do you profit by someone else's experience unless you wait for him to act first? I think you must stop criticizing the press—much of whose reporters have a great deal more competence and experience in interpreting Communist statements than you have—for misinterpreting the Khrushchev statement. I think *you* have misinterpreted it.

Nothing is to be gained by casting aspersions on those who would hold space program costs within a smaller budget, or by implying they are losing the cold war by that slowdown. We have a hard enough job defeating Communism without spilling blood over schedules, especially when you still have not convinced me, or a lot of others, that we *need* a crash program to beat the Russians. (And for you to say *Apollo* is not presently a crash program is in itself an astonishing event.) As an employee of a large aerospace firm myself, I stand to lose indirectly if NASA expenditures are cut. But I do not expect to lose as a citizen, either in my security or in my pocketbook.

Rinehart S. Potts
Levittown, N.J.

Orion and the Bear

To the Editor:

With reference to Project *Orion* (M/R, Nov. 4, p. 34), do you suppose the fact that the U.S. long ago developed the necessary "baby" nuclear charges, while Russia has not yet developed them, could have had anything to do with Russia's desire for the test ban? The ban will restrict our thinking on using nuclear charges for propulsion —though it shouldn't. Meanwhile, Russia has been given the time to develop the needed "baby" nuclear charges underground. When Russia has them, Russia will use them. It does not take a whole lot of thought for anyone to see the potentiality in such a propulsion system. It would require a minimum of development. It is economical, reliable, safe, and would enable carrying the heavy shielding required for protection against solar flares on long space voyages. It should have enabled us to leapfrog ahead of Russia—it might yet.

T. M. Morse
Santa Maria, Calif.

STL NEW PROPULSION OPPORTUNITIES
In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

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The Countdown

WASHINGTON

GO Loses A Year in Schedule . . .

First launch of NASA's *Orbiting Geophysical Observatory* has now slipped into 1965. It was once scheduled for early next year. Officials say the delay is caused by work on the spacecraft structure.

. . And Later on, Saturn and Apollo

First launch of the *Saturn IB,* originally slated for the third quarter of 1965, is now off until the first quarter of 1966. First manned *Apollo* flight on the booster is scheduled for late in that same year, but now will likely drift into 1967. NASA last year said it would be receiving one man-rated *Apollo* every three months by the third quarter of 1964. This target date has now become the third quarter of 1965.

luminum Expected in MOSS Structure

Likeliest possible material for a *Manned Orbiting Space Station* is aluminum, say officials at Langley Research Center. A nuclear power unit under development at Lewis Research Center is also being considered for use in the six-man station which Langley is studying. The SNAP-8 system under development by Aerojet-General is not in contention.

oyager May Need Multiple Managers

Diversified center management of projects is a new prospect in NASA's unmanned interplanetary spacecraft programs. First trial of the method could be in the *Voyager* program, which officials feel is so complex that more than one center may be involved. Besides JPL, other centers handling the program could be Goddard, Langley and Ames.

INDUSTRY

ouglas Center To Test Huge Future Boosters

A new $25-million space systems center for Douglas Aircraft Co. at Huntington, Calif., can carry out structural tests on post-*Nova* vehicles up to 60 ft. in diameter and delivering 8 million lbs. of thrust. First major space program will be assembly and checkout of the S-IVB second state of the *Saturn IB*. Possible follow-on is adaption of the S-IVB into a manned orbiting research laboratory for four to six men, capable of remaining in orbit one year and remanned by *Gemini* vehicles launched by *Titan.* C. R. Able, vice president and general manager of Douglas' Missile and Space System Div., hinted that a recent study showed such an adaption was feasible. Also installed at the center is a man-rated 39-ft.-dia. space chamber that can take complete S-IVB stages.

turn Pad May Not See Service

NASA will decide this week whether Pad "A" of *Saturn* Complex 37 at Cape Canaveral may be left to lie fallow and never be used for a rocket launch. Construction work on the "brick-and-mortar" portion of the launch pad has been finished, but electrical work, plumbing and connectors may not be installed. Launch Operations Center planners feel it will be cheaper to revamp Pad "B" for the *Saturn IB* launch, because plumbing and wiring already are in place on the launch stand and umbilical mast. Present plans call for Pad "B" and the single stand of Complex 34 to be converted to the *Saturn IB* mission, with Pad "A" remaining as a backup for conversion if and when needed.

Florida Seeks More Contracts

In an effort to get more space business for Florida, a conference expected to attract some 1,500 manufacturers and business leaders in the state will be held in Orlando on Dec. 3-4. It will be attended by representatives of NASA, Defense Dept., Small Business Administration, Dept. of Commerce, and prime missile/space contractors. Florida Congressional leaders also are expected to take part.

INTERNATIONAL

French Acknowledge Space Economic Benefits

The French government has formally recognized the direct and indirect benefits accruing to her already prosperous economy from aerospace and nuclear work. An official report notes that of the 13,000 persons employed in the rocket development program, 5,000 are in electronics and 5,000 in chemical-metallurgy. Of 14,000 persons working at the Pierrelatte nuclear center, 92% are employees of private industry.

Dutch Gain ESRO Center Speed-up

Officials of the Netherlands government are highly pleased by the recent decision of the European Space Research Organization to speed construction and installation of the main ESRO research center in that country. Delft remains the most probable site.

Spanish Space Commissioners Named

The Spanish National Commission for Space Investigation will be headed by Rafael Calvo Rodes, also president of the Spanish National Institute for Aerospace Technology. Vice president will be Vincente Gill Mendizabal, secretary Antonio Rodriguez Carmona. Other members of the board include Julian Rubio, president of Iberia Air Lines, and Luis de Azcarraga, an Iberia vice president.

French 1964 Missile Plans

Major missile effort covered in France's 1964 budget is launching of the *SSBS (Sol-Sol-Balistique-Stratégique)* ICBM-type weapon, scheduled to become operational with the French Air Force about 1966. SSBS will be the transition weapon between Mirage IV bombers carrying nuclear bombs and the MSBS *Polaris*-type missiles to be fired from submarines (see p. 18). Defense Minister Pierre Messmer also announced recently that the first French-built *Hawk* missiles would become operational with French units before the end of 1964, and that during the next year additional French Navy ships will be re-equipped with *Tartar* and *Malafon* missiles.

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engineering skills . . .

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SPACE DIVISION **CHRYSLER CORPORATION**

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he Missile/Space Week

ew Launch Target for IMP

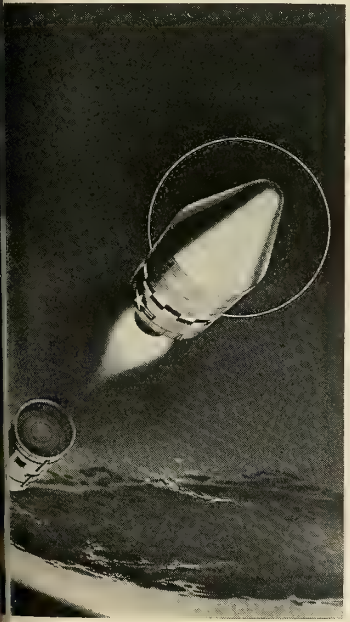
The Interplanetary Monitoring latform (IMP), scheduled for unch Nov. 12 from Cape Canaveral a three-stage *Thor-Delta,* was ruptly postponed when tests re-aled third stage exhaust gases ight contaminate the spacecraft at treme altitude. Next try is re-rtedly set for the first week in ecember.

Ground tests of the X-259 solid opellant stage were run the previ-s week in an altitude-simulation amber at the Arnold Engineering nter, Tullahoma, Tenn.

Test results confirmed suspicions at trouble with previous payloads may have been caused by exhaust gases after the stage finished its burn. This stage has been used on the NASA *Scout.*

Changes will be made in the separation sequence to eliminate the possibility of contamination.

Titan III Payload Fairing Detailed by Fairchild



NDARD PAYLOAD fairing (circled his artist's drawing) for the Air Force n III standard space launch vehicle be built by Space Systems Div., Fair- l Stratos Corp., Rockville, Md. The cal fairing will protect payloads atop n III, and will be fabricated under a ntly awarded $1,650,000 contract from tin Co. The fairings will be 18 ft. high 10 ft. in diameter.

Hornig Succeeds Wiesner

Donald F. Hornig, chairman of the chemistry department at Princeton University and a member of the President's Science Advisory Committee, will succeed Jerome B. Wiesner as White House science adviser and director of the Office of Science and Technology.

President Kennedy chose the 43-year-old Hornig, who will assume his new duties when Wiesner leaves the position in two or three months. Wiesner is returning to the Massachusetts Institute of Technology.

Hornig will be the fourth to fill the office since its creation by the then President Eisenhower in 1957. MIT's James E. Killian and Harvard's George B. Kistiakowsky preceded Wiesner.

Shots of the Week

North American Aviation and NASA conducted the first pad abort test flight of an unmanned *Apollo* command module Nov. 7 from White Sands Missile Range, N.M., (see cover picture).

Powered by its Lockheed-built 155,000-lb.-thrust launch escape motor, the full-size boilerplate model rose to 4,900 ft. before being returned by three parachutes.

The four-nozzle escape motor provided 8 seconds of vertical boost, which was followed by a ½-sec., 3,400-lb. horizontal thrust from the pitch-control motor to induce lateral displacement of the craft.

After burnout of the second motor, four explosive bolts holding the escape tower to the module were fired and the 33,000-lb.-thrust tower-jettison engine propelled the tower from the module. The parachutes then deployed to ease the craft back to the ground.

Other shots of the week:

- The Air Force successfully fired an *Atlas D* ICBM from Vandenberg AFB, Calif., Nov. 13. Accuracy of the shot was not immediately disclosed.
- The Air Force on Nov. 13 successfully fired a new Wing VI *Min-*

Immediate openings in:

AEROBALLISTICS

Aerothermo Mechanics (aerodynamic testing, analysis, stability and air loads; wind tunnel model design; heat-transfer studies; thermodynamics of power systems and cryogenic storage; aerothermo research in theoretical gas dynamics and computer programs.) Flight Mechanics (trajectory analysis, optimization and staging, guidance and control, orbital and space rendezvous mechanics, evaluation of overall performance, launch and separation dynamics, celestial mechanics, elastic body feedback stability, elastic body wind response and dynamic analysis.)

ELECTRICAL and ELECTRONICS

Electromechanical design of space vehicle equipment for power distribution and switching, control and measuring networks; electrical design of power supplies, voltage and current regulators and inverters in low power range; cable and harness design for space vehicle, check-out and launch equipment, perform load studies, prepare environmental, acceptance and qualification test specifications complying with MIL-Specifications and Standards, and prepare and interpret design criteria.

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uteman from Cape Canaveral. Incorporating an advanced second-stage motor, the missile flew some 5,000 miles down the Atlantic Missile Range. The new stage is equipped with one stationary nozzle, rather than the four movable nozzles used on the Wing II *Minuteman.*

- NASA launched an *Aerobee 150A* rocket from Wallops Island, Va., Nov. 12. Mission was to discover techniques for determining oxygen content in the neighborhood of the Moon.
- The Soviet Union took another step forward in its space program Nov. 12 with the successful launch of *Cosmos 21,* an instrumented satellite, orbit of which is inclined 64° 50′ to the equator. Apogee is 142.1 mi.; perigee, 120.9.
- The Navy's second successful underwater firing of a *Polaris A3* ICBM was accomplished Nov. 11 from the U.S.S. Andrew Jackson 30 miles off the Florida coast near Cape Canaveral.
- The Air Force conducted a silo-launch of a *Titan II* from Vandenberg AFB, Calif., Nov. 9.
- Also on the 9th, the Air Force used a *Thor-Agena* rocket combination to launch a secret satellite from Vandenberg.
- NASA's *X-15* rocket plane was flown Nov. 7 in a heat transfer test. Piloted by Air Force Maj. Bob Rushworth, the craft reached 2,864 mph and an altitude of 82,000 ft.
- An Air Force *Minuteman* ICBM went out of control and exploded shortly after lift-off from a Cape Canaveral launch pad Nov. 7.

Spacecast Bands Assigned

Seventy member nations of the International Telecommunications Union have allocated radio frequency bands totaling 6,076 megacycles for space communications activities, four 500-mc bands specifically for communications satellites.

The five bands are: 3,700-4,200 mc (space to Earth); 5,925-6,425 (Earth to space); 7,250-7,750 (space to Earth—with 7,250-7,300 mc set aside for exclusive communications satellite use, except in certain countries); and 7,900-8,400 mc (Earth to space—with 7,975-8,025 mc for exclusive communications satellite use, except in some countries).

An additional 800 megacycles (3,400-4,200 mc) have been allocated to communications satellite use by region to be shared with other forms of communications:

—3,400-4,200 mc (Earth to space) shared with fixed and mobile communications in Region I (Euro and the Soviet Union).

—3,400-3,500 mc (space to Eart shared with radio location in Regi II (Western Hemisphere) and R gion III (Far East).

—3,500-3,700 mc shared with r dio location in Region III and wi radio location and fixed and mobile Region II.

—4,400-4,700 mc (Earth to spac shared with fixed and mobile in three regions.

—5,725-5,850 mc (Earth to spac shared with radio location in R gion I.

—5,850-5,925 mc (Earth to spac shared with fixed and mobile in R gions I and III.

In addition, the conference a proved the allocation of the 1,4 1,427-mc band for exclusive wor wide use in radio astronomy and t 144-146-mc band for exclusive wor wide use by radio amateurs. Oth frequency uses covered by the agr ment include space research, mete ological and navigational satelli and aeronautical space services.

Martin Strike Short-Lived

A strike that threatened to d rupt work on the *Titan II* boos for NASA's *Gemini* spacecraft las less than three hours last week.

Some 8,500 members of United Auto Workers began walki off the job at Martin's Co.'s Ba more, Denver and Orlando, Fla., visions at 2 p.m. Nov. 13, but UA Vice President Leonard Woodc announced at 4:55 the same day t tentative agreement had be reached in contract negotiations w Martin management.

UAW workers were urged to turn to their jobs Nov. 14. The c tract was to have been submitted union ratification at members meetings Nov. 17.

The final stumbling block in ne tiations that had been under way about a month was described b Martin spokesman as an "econo package," no details of which h been disclosed.

Cape Strike Continues

The wildcat strike of member Local 780, International Alliance Theatrical and Stage Employ kept more than 1,000 persons off job at Cape Canaveral Nov. 13.

The 285 photographer contract walked out more than two weeks in a contract dispute.

Some 450 carpenters honored photographers' picket line Nov.

nd an additional 450 electricians,
lumbers and other building trades-
nen were sent home because their
vork depends on that of the car-
enters.

The photographers' strike was
ot sanctioned by the parent organi-
ation, and union officials in the area
ave urged the carpenters to return
o work immediately to comply with
he no-strike pledge given at missile
ites throughout the country.

apan Plans Space Agency

Japan's Science and Technology
gency has announced plans for a
-year space program covering de-
elopment of Japanese booster sys-
ems and three satellite launchings.

The program is funded at $59,-
38,888 and will employ some 300
apanese engineers.

Administering the program will
e a Space Development and Propul-
on office, to oversee both booster
nd satellite development. Four di-
sions will make up the office: Gen-
al Affairs, staffed by 38 men; Plan-
ing, staffed by 80 men; Rocket De-
elopment, with a staff of 90; and
xperimental Control, with 40 men.
ork of the headquarters section
ill be monitored by a steering com-
ittee, composed of related industry
presentatives, government officials
d scholars.

Specific programs planned by the
gency include:

—60-kilometer weather observa-
on rocket; test production program
lls for six in 1964, ten in 1965,
irty in 1966 and ten in 1967.

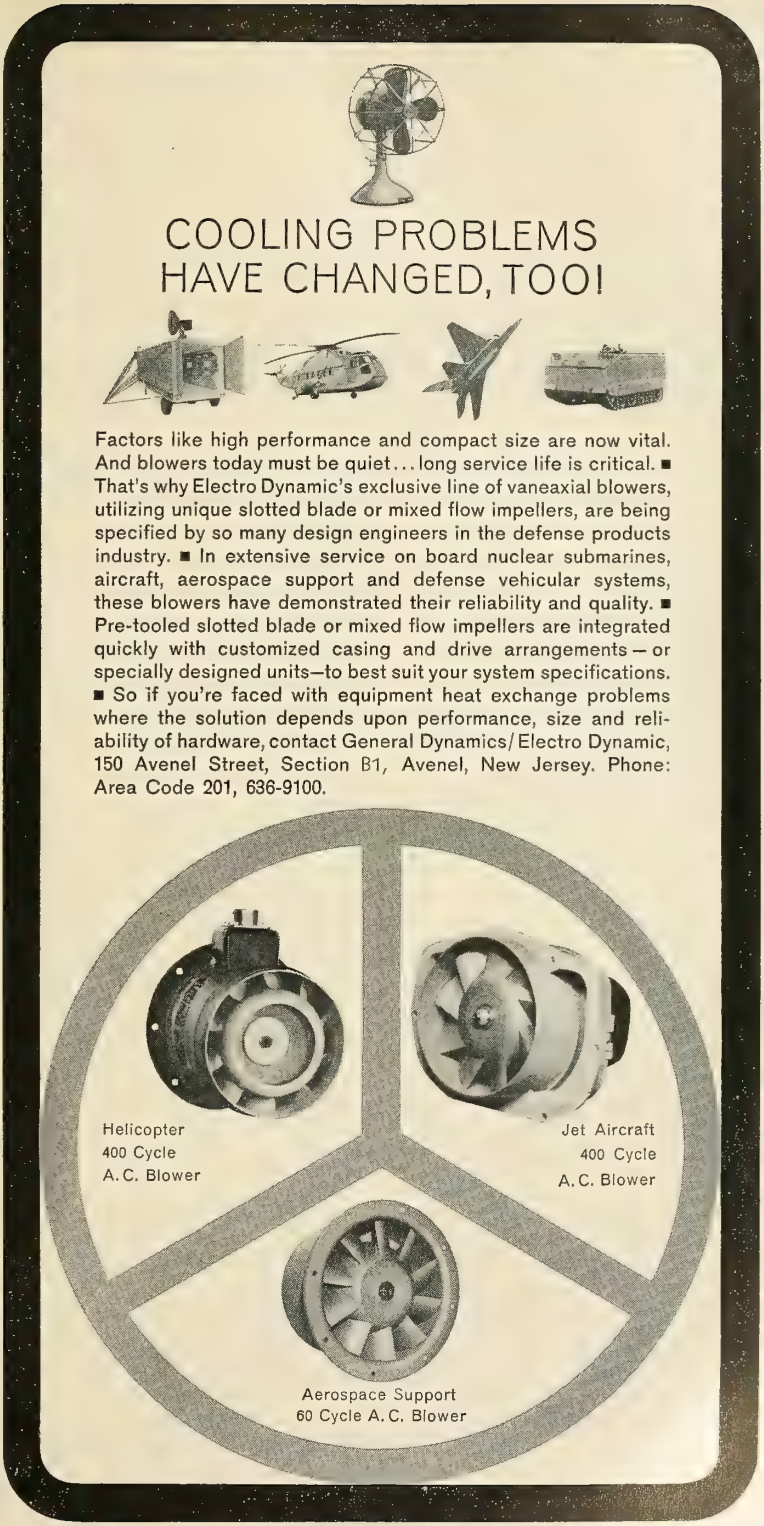
—150-kilometer two-stage
eather observation rockets; pro-
ction program calls for three in
64, four in 1965, seven in 1966 and
n in 1967.

—400-kilometer two-stage rock-
s; research work on engines and
idance and control devices will be
arted in 1963, and launching
anned in 1967.

—800-kilometer three-stage rock-
s; research work on the control and
idance devices and engines will be
rted in 1965, and launching tests
1965-66.

—1,200-kilometer two-stage rock-
s; research work on engines and
idance and control devices will be
rted in 1966-67, and launching in
67.

—navigation satellites; develop-
nt work will be started in 1964;
tailed designing work in 1965; test
oduction of entire system in 1966,
d NASA asked to launch satellites
1967.



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By Senate committee . . .

$5.19 Billion Voted for NASA

Full Senate could act this week; Mueller says he'll seek supplemental request; Administration may have eased pressure

NASA'S FISCAL 1964 MONEY bill has emerged from the Senate Appropriations Committee with only a moderate increase over the House-approved bill, bringing it to $5.19 billion.

If the bill is passed by the full Senate with no change, the conference committee of House and Senate appropriations committee members will have only a $90-million difference to resolve. Speculation is that it will favor the Senate figure, ending up about $60 or $70 million above the House version.

• **Supplemental**—Associate Administrator for Manned Spaceflight Dr. George Mueller told MISSILES AND ROCKETS that he will request supplemental funds up to the authorization level of $5.35 billion.

Mueller said that unless this money is forthcoming, work on backup navigation systems, reaction controls, fuel cells and parts of the *Apollo* Lunar Excursion Module cannot be started. This money must be appropriated this year, he added, since they will be critical systems two years from now.

Dr. Edward Welsh, executive secretary of the National Aeronautics and Space Council, which must approve any supplemental request, said "the Administration will be influenced by a strong recommendation from NASA administrator James E. Webb." Earlier, Deputy Administrator Dr. Hugh L. Dryden had told M/R that the space agency probably would make a supplemental request, although NASA now says it will reserve comment until the Senate completes action upon the bill.

Other Administration sources said that it was doubtful that the Administration would approve such a request—primarily because of the feeling that if a supplemental appropriation were submitted in January or early February it would not be approved until after the end of Fiscal Year 1964 next June 30.

Sen. Warren G. Magnuson (D-Wash.), chairman of the Independent Offices Appropriations Subcommittee that handled the NASA budget, summed up Congressional feeling about the supplemental funds by saying "we'd give it some consideration, but we're sure this (the present bill) will keep the program going as they (NASA) anticipate."

• **Losing steam?**—The relative lowness of the amount restored by the Senate to the House bill, coupled with the fact that the President did not consult Congressional leaders prior to his space cooperation proposal at the U.N. in September, has led to questioning whether the Administration is losing some of its feeling of urgency about the space program. The surprise invitation to the Soviets ruffled feelings among the space program's staunchest Congressional supporters.

Magnuson commented that the Appropriations Committee felt NASA "could get along fine" with this amount and "proceed with reasonable diligence with their plans." He added he didn't think they would miss their Moon-landing deadline date of 1970.

• **Will go on floor**—The subcommittee chairman said that he still hopes to get the bill through Congress before Thanksgiving. Floor action is not expected until the end of this week or perhaps Monday, Nov. 25. Conference action should be rapid because of the nearness of the amounts, and approval of appropriations conference bills takes precedence over other floor action.

• **Senate action**—The Senate committee added an $80-million restoration in research and development funds, and $10 million in construction. Administrative operations funds remained at the House level, and Magnuson pointed out that the current bill allows no mor personnel in any of the Independen Offices, including NASA.

The committee wrote a new claus into the bill curtailing academic gran programs by NASA, projected to cos between $21 and $28 million per yea in the near future. "Because of th overlap with other governmental-gran education programs, the committe questions the propriety of such a pro gram administered by this agency, an therefore directs that no new grants b made without specific authorization an appropriation."

• **Soviet clause**—While the Hous bill carried a clause forbidding that an funds be used in a joint manned luna landing with the Soviets, the Senato extended this to "any other country and added the wording "without conse of the Congress."

Magnuson and other Senators re iterated denials that any of the recen Soviet statements affected their vote and said the matter had not even bee mentioned in the markup sessions.

The Senate bill amounted to $52 million below NASA's original reque of $5.712 billion, and $260 million be low the authorization of $5.35 billio

In a letter to the Senate committe the U.S. Chamber of Commerce mad a last attempt to get the bill slashed t $4.5 billion on the basis that the pro posed increases might actually impe our present space effort."

The Chamber said NASA's expend ture rate can have a more deleteriou than beneficial effect on the industri economy, because of its absorption o qualified manpower. "The impact wi not be mitigated by potential industri applications, because there is no co trol over the receptivity of the econom to capitalize on innovation which ma possibly come out of the program."

'Much better vehicle . . .'

Centaur Officials Hopeful Of Successful Second Launching

CAPE CANAVERAL—NASA has scheduled the second *Atlas-Centaur* launch between 10 a.m. and 4 p.m. Nov. 26 from Complex 36A.

If the launch is successful, the entire second stage will enter an elliptical orbit included at 100.5 degrees with a perigee of 300 mi. and an apogee between 800 and 900 mi.

Telemetry, C-band beacons and Azusa transponders are scheduled to continue operation through about four orbits, or until the on-board batteries reach the limit of their expected 10-hr. life.

A *Centaur* project spokesman said last week "*AC-2* is a much better vehicle than the first one" and added that little trouble is expected.

The first *Centaur* stood on the launch pad for nearly a year before it was launched May 8, 1962. An insulation panel broke loose in flight and the vehicle exploded 55 seconds after liftoff.

Program representatives said the initial vehicle was "nearly rebuilt" during the long months it stood on the launch pad. Many changes and modifications were incorporated into the stage during the long delay.

Atlas-Centaur 2 "was in good shape when it arrived," but has undergone ome modifications during the few weeks it has been at the Cape.

Project spokesmen say they feel it s a "much better bird" because it conains an additional 18 months of reearch and development, which have roduced the more advanced RL-10-A3 liquid hydrogen engine, improved pumps and advances in many other sysems.

AC-2 also will carry a later and improved version of the Honeywell guidnce system that will control both stages n inertial flight after the first stage flies hrough the booster engine phase on utopilot.

The *Centaur* launch window of 10 m. to 4 p.m. was dictated by the availbility of light for photographic coverge of the launch. Since photography is a "must," the launch will not take place if there is a cloud cover or if the launch slips past the 4 p.m. cutoff.

If the launch is successful, project officials predict the next *Centaur* launch will take place next March.

• **Modifications**—The *Centaur* vehicle has been radically changed for the upcoming flight, and further changes will be made before the March launch. Officials said that the changes are being made in piecemeal fashion in an attempt to get a successful flight as soon as possible. If the present changes do not work, others will be tried.

The major change for next week's flight is the use of the improved A3 version of the RL-10 engine.

Another calls for a ground chilldown using liquid helium. Previously, the engine was chilled down by running hydrogen through the engine for 20-odd seconds during the flight. The ground chilldown is considered safer.

Other changes include:

—Separation of the *Atlas* and *Centaur* will be accomplished with a new linear-shaped charge, instead of explosive bolts used in the first flight.

—Revised hydrogen vents have been installed to make sure that when the hydrogen is vented into space it does not come into contact with the flaming end of the vehicle.

—Insulation panels will not be jettisoned.

• **Karth hopeful**—Rep. Joseph E. Karth, chairman of the House Space Sciences subcommittee, said in San Diego following a day-long briefing on *Centaur* that he thought *Centaur* was "not only going to work, but should be a whopping success."

Karth told M/R that he based his opinion on the technical changes made, as well as on the fact that a more rigorous and extensive test program has been undertaken, adding, "it just has got to work because it has one of the major responsibilities in supporting the manned lunar program. If it does not work, the program will be delayed."

Noting that substantial changes have been made in program management by both General Dynamics/Astronautics and NASA, Karth said major technical changes included a switch from spot welding to fusion welding on hydrogen tanks, and adoption of simultaneous firing of a combination of retro-rockets and posigrade vernier rockets to separate *Centaur* from *Atlas*. The latter change produces quicker separation and reduced chance of a collision between the two stages. The welding process change was made because hydrogen was found to leak past spot welds, Karth said. ■

Three Firms To Negotiate for MILA Contract

NASA HAS SELECTED three companies for negotiations leading to the award of a prime contract to provide administrative and management services to the NASA Merritt Island Launch Area.

The firms are the Tech. Rep. Div. of Philco Corp., the Range Systems Div. of Ling-Temco-Vought, Inc., and the RCA Service Co.

They were selected from 23 firms that submitted proposals on Oct. 14. Proposals were requested by NASA from 216 companies.

The one-year contract will be a cost-plus-incentive-fee award and may be continued for two more years. It is expected to total about $2.5 million.

Four distinct types of service will be included in the contract—automatic data processing, technical information, photographic and the operation of the field printing site.

$5-million funding . . .

Rocketdyne Developing Rugged Grains

High-performance solid motors would enjoy lower inert weight, increased efficiency; concept is unique

AN AIR FORCE Advanced Development Program was recently awarded to Rocketdyne's Solid Rocket Div., McGregor, Tex., for advanced development of high-performance solid rocket motors that have a propellant grain with rugged structural capabilities.

The contract, originally awarded in April, 1963, has a 24-month duration and is currently being funded as Program 674A for about $5 million. Significant reduction in motor inert weight with an increase in ballistic performance are additional objectives being sought with a unique propellant grain concept. The reinforced grain design provides for wire forms to be incorporated into the propellant to add structural strength, much as a glass roving-resin system is used in the manufacturing of fiberglas cases.

Added strength of the wire forms allows motor operation at high chamber pressures, which results in improved combustion efficiencies. The grain construction furthers the motor's capabilities to absorb compression, bending, shear, and torsional loads associated with flight conditions. Reinforced grain motors provide the additional advantage of being operative under stresses imposed by extremes of vibration and temperature. The predicted propellant mass fraction is improved over conventional solid rocket motors due to the grain's pressure vessel capacity, which permits an extremely lightweight outer case to be employed.

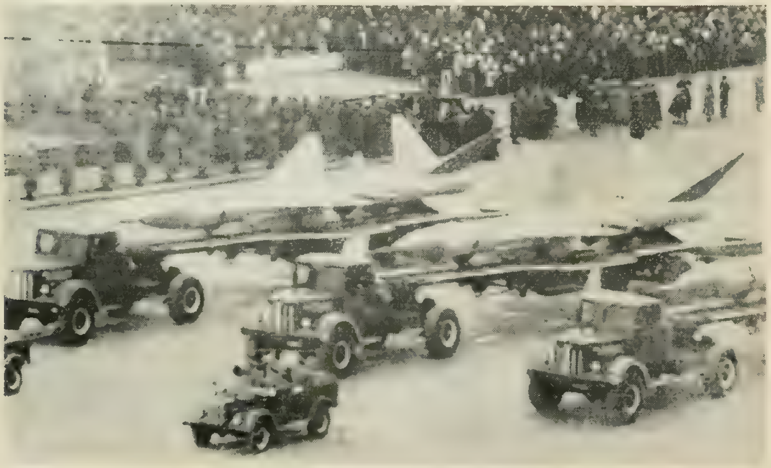
- **Process**—Manufacturing essentially involves three operations: build-up of the reinforced propellant grain shell over a mandrel; wrapping a fiberglas case over the propellant shell; and casting additional propellant into the remaining core volume.

The mandrel is first coated with a specified thickness of highly viscous propellant. Wire is then wrapped on the mandrel under a tension that allows for uniform build-up in the propellant layer. A number of the propellant-wire layers are required in the complete manufacture of the motor. After the grain build-up is accomplished, the propellant system is cured and insulation is bonded onto the surface of the grain. A fiberglas case that has a low temperature cure resin system is wrapped over the insulation. The mandrel is then removed and propellant is cast into the remaining chamber volume.

To maintain control over the pressure-time performance and to allow for decreasing structural strength with consumption of the grain, the propellant burn-rate is varied radially outward for each propellant layer. The fiberglas case design is defined by the flight loads and chamber pressure occurring near motor burn-out.

The motor program has the basic objective of demonstrating the feasibility of reinforced grain technology for high-performance upper-stage motors. Several motors will be tested with a thrust-vector-control system and thrust reversal ports. The nozzle-TVC system will consist of a submerged nozzle assembly with an omni-axial gimballed exit cone. ARDE-Portland has been selected to design, fabricate and assemble this system.

The basic research supporting this Advanced Development Program has been obtained on a USAF Applied Research Program with Rocketdyne. Both contracts have been managed by the Air Force Rocket Propulsion Laboratory at Edwards AFB, Calif., one of the laboratories assigned to the Research and Technology Div. of Air Force Systems Command, Bolling AFB, Washington, D.C. ∎



Russian 'Fly-Swatter' Fails to Startle

U.S. OFFICIALS were not overly impressed with the Soviets' "stratospheric fly swatter" antimissile missile, shown here i its first showing during the Nov. 7 Moscov parade commemorating the 1917 Bolshevi revolution. Defense Dept. spokesmen sai the U.S. Nike-Zeus was at least its equal Actually, the weapon appears to be a improved-performance antiaircraft missile Long fins with high aspect ratio shoul limit speed to Mach 3. Nose configuratio relegates it to Mach 5.

Wide range of subjects . . .

LOC Presses Studies to Keep Abreast of Growing Launch Problems

Eleven out-of-house studies contracted or proposed for this fiscal year; twelve more envisioned for 1965 and later years

by Chris Butler

CAPE CANAVERAL—A vigorous study program will be conducted by NASA's Operations Center in Fiscal 1964 to identify and solve current launching problems and to plan for facilities to meet requirements of future boosters and spacecraft.

In the current fiscal year, 11 out-of-house studies are either under contract or in the process of being proposed for contract.

An additional 12 study programs have been identified for activation in 1965 and beyond.

All of these studies are handled through the Future Studies Branch of the Launch Support Equipment Engineering Div. of LOC, which is located at Marshall Space Flight Center in Huntsville, Ala.

• **Contracted**—Out-of-house study programs for Fiscal 1964 are:

—*Facility concepts for large-thrust vehicles*—A study to develop concepts for launch complex support equipment and facilities for such vehicles. Part I will consider operational requirements, costs, availability and reliability factors. Part II will continue the study to define the optimum facility concept for the selected large vehicle.

—*Leak detection methods*—An investigation of methods beyond the present use of pressure-drop, halide detectors and bubbling solutions to find leaks. It will place primary emphasis on conceptual design of an automated prelaunch leak detection system for a typical space-vehicle stage. Secondary emphasis will be placed on adaptation of on-board hardware to an automated system compatible with, and operable in, a space environment.

—*Region of LH_2 boiloff rates*—This will investigate techniques of reducing LH_2 boiloff losses and provide design criteria for accepted methods of loss reduction.

—*Helium use and reuse techniques*—This study will examine the most economical techniques for using gaseous and liquid helium since it is expensive and in short supply. It also will determine acceptable substitutes, define minimum uses when no substitute can be found, and examine reclamation methods.

—*Advanced launcher and deflector-related studies*—This will determine requirements and designs of launchers and deflectors for *Nova* and post-*Nova* class vehicles. It will utilize vehicle configurations selected from current and planned studies. It will consider such factors as solids, plug nozzles and recoverable boosters which could cause changes in launcher design.

—*Special mission support equipment and facilities required for future missions*—This study is to define additional facilities required at Merritt Island to fulfill orbital and lunar missions. It will include such things as facilities for handling exotic fuels and subcooling LH_2.

—*Cryogenic propellant storage and transfer techniques*—This will generate and evaluate new methods of cryogenic handling and storage. Included will be LOX, LH_2 (possibly subcooled to slush) and fluorine storage. Transfer on Earth and in orbit will be considered.

—*High pressure-high flow rate flexible hoses and couplings*—Purpose of this is to provide a development and testing program for high-pressure flexible hoses and couplings to load various chemicals on space vehicles at high flow rates. These chemicals will include such exotic propellants as fluorine and boron-based fuels.

—*Improved launch site assembly and checkout techniques*—This study is to minimize the time consumed for checkout of launch vehicles to help meet the requirements imposed by decreasing limits of launch windows for space missions.

—*Facilities for solid-propellant vehicles*—This study is to define in detail launch facility requirements and launch operations for solid-propellant vehicles equivalent to the *Saturn IB* and *Saturn V*. It will determine the most feasible launch concept for large solid-propellant vehicles and the most feasible vehicle configurations, then detail the selected concept with appropriate design criteria based on the selected vehicle configuration.

—*Launch facilities for orbital operations*—This will investigate the impact of orbital operations on LOC and develop equipment and operating procedures to permit a reliable and successful orbital program.

• **At home**—The current in-house studies are:

—*Lunar logistics system*—Preliminary work statements, test and development programs and facility requirement definitions for the proposed lunar roving vehicle.

—*Advanced orbital launch operations*—Contribution of an extrapolation of experience in checkout and launch for use in a Marshall-funded study of advanced launch operations for Earth and orbit in the post-*Apollo* period through 1980.

—*Exotic propellant facilities*—A preliminary study to examine facilities, support equipment and hazards associated with fluorine, chlorine trifloride, diborane, pentaborane, decaborane and similar propellants.

—*Supporting technology and advanced studies control handbook*—This book will contain centralized control information on supporting technology and advanced studies for which LOC is responsible.

—*High-pressure gas storage*—This two-part study covering storage of gases on Earth and in orbit was continued from Fiscal 1963.

—*Launch facility nuclear safety*—A continuing study to keep LOC abreast of advancing nuclear rocket engine technology.

—*Thermal design of launch deflectors*—This is to determine the temperature profile of a launch deflector plate as a function of time. ■

Despite solids progress . . .

Operational Polaris-type French Sub Fleet 10 Years Away

by Frank G. McGuire

PARIS—Reading the fine print of French defense planning reveals the same tendency to overstate capability that often afflicts the United States. Official reports to the National Assembly's Defense Commission on the Defense Budget now indicate that a truly operational force of at least three *MSBS* (*Polaris*-type) submarines will not be available until 1973—despite the fact that the first submarine is still expected in 1968-69.

Government sources have been using the earlier date in public discussions of the independent French nuclear force, but M. La Theule, a Gaullist deputy, reported to the budget commission that the force could not really be called operational until at least three submarines were in service, thus tactfully correcting the record without contradicting the government. The three submarines probably will be joined by two others, for a total complement of five.

Earlier, Adm. Cabanier, French Navy Chief of Staff, said "the initial complement" of submarines would be operational in 1968-70 (M/R, Oct. 28, p. 11), and the semi-official publication *National Defense Review* estimated a similar time period. Differing dates have been quoted in various publications and announcements during the past few months, and *National Defense Review* gave a date of 1966-67 for launching of the first submarine, 1968-69 for it to be in service. No date later than 1970 was mentioned for operational status of the entire force until M. La Theule's statement that the government could not really consider one submarine an operational nuclear force.

● **Timetable**—Overall schedule for the French nuclear strike force is said to be one year ahead of schedule, with the various elements lining up as follows:

—*First Generation:* Mirage IV bombers armed with 60-kiloton nuclear weapons until 1966-67, then with thermonuclear weapons. The bombers are expected to be operational next year, with a total strength eventually of up to 90 aircraft.

—*Second Generation: SSBS* surface-to-surface ballistic missiles with 1,300-mi. range using solid propellants, expected to be operational in 1966-67, total numbers unknown.

—*Third Generation: MSBS* sea-to-land ballistic missiles of same general concept as *Polaris,* carried aboard 7,000-ton submarines in 16-missile groups and armed with a thermonuclear warhead. These are to be operational as an effective force by 1973, with individual submarines entering service at two-year intervals beginning about 1968.

Although the delivery vehicles will be on hand, French nuclear and military experts doubt that warheads will be available. The isotope separation plant expected to turn out raw materials will not be in operation itself before 1967, and although enough materials can be produced to fabricate nuclear weapons for the number of Mirage IV bombers to be operational next year as the first generation, there is no indication which type of warhead the second-generation *SSBS* missile will carry.

The *SSBS,* according to M. La Theule, was decided upon because of a gap of seven years (1968-75) between the Mirage IV bombers and the *Polaris*-type force. The disparity of technology involved in going directly from jet bombers to ballistic missiles fired over long ranges from submerged submarines apparently also played a part in the decision. As a somewhat intermediate step, the French chose to develop a land-based ballistic missile without introducing the problems of a moving submerged launch platform.

In an accessory vein, M. La Theule said there will also be a 12 year gap from 1963-75 while the French army is being completely re-equipped with modern conventional weapons. During this time period, he said, France must be a member of some alliance, but the United States must realize it is impossible for Europe to continue being totally dependent upon American strength.

M. La Theule's remarks pointing out government defense-planning deficiencies were particularly noteworthy because he is a government deputy in the National Assembly.

● **Solid rockets hold key**—One of the strongest pillars upon which France is building her independent nuclear force is the solid rocket industry, which is making rapid strides in basic technology.

In 1959, French rocket industry spokesmen estimated France was five to eight years behind the United States in solid-propellant technology; they now feel that this difference has been cut in half. French officials give due credit to the considerable flow of basic data between the two countries; this has enabled them to confine their high-priority research to problems most in need of solution.

One major French rocket firm, Société d'Etudes de la Propulsion par Reaction (SEPR), has fired a number of high-thrust solid rockets using movable nozzles and large propellant masses. One recent firing at Istres was of a monolithic unit reportedly nearly five feet in diameter and containing two and a half tons of propellant. The 30-ft. exhaust flame described a 15-degree cone, while the hydraulically-actuated nozzle was continuously exercised throughout the test. Burning time was about 60 seconds and temperatures reached 3,000°C, while exhaust velocity was about 4,000 meters/sec.

The principal objective was to test nozzle retention with new materials at high temperatures and exhaust velocities. Sources said SEPR engineers expected the nozzle to part from the motor, but retention was excellent. The motor was mounted on ball bearings to permit rotation during the firing. The thrust axis was offset 15 degrees.

(Unconfirmed reports from other industry sources in Paris say tests are being prepared for a solid rocket motor containing 20 tons of propellant and approximately 60 ft. long.)

The largest of eight test cells at Istres can handle solid rocket tests generating up to 150,000 lbs. of thrust from motors five feet in diameter and 18 ft. in length. Other cells are for altitude simulation, destructive testing, thrust-termination experiments, vertical firings, precision calibration, and similar tests.

The SEPR center at Istres was founded in 1954 and now employs 200 persons. ■

Technical Countdown

ELECTRONICS

Laminated Integrated Memory Developed

Tissue-thin ferrite laminates can be stacked and cured, producing a standardized low-cost computer memory. The miniature integrated storage devices, produced by a new RCA Laboratories process, can be fabricated either to achieve very high speed or very large capacity, considering the small size. One unit, RCA disclosed, is the size of an aspirin, stores 256 data bits, and has a processing rate of 10^6 bits/sec. Another, measuring 0.005 x 1 x 3 in., has a 16,384-bit capacity, and with further development, RCA scientists predict an eventual capacity of 10^6 bits.

Early Advances in Gyro Accuracy Forecast

The U.S. will have gyroscopes capable of detecting angular motion deviations as small as 0.01 sec. of arc within the next two years, predicts Dr. Charles S. Draper of MIT's Instrumentation Laboratory. Speaking recently at the Fourth Annual Space Technology Seminar at Patrick AFB, Fla., the inertial guidance expert also disclosed that MIT's first complete *Apollo* guidance system will be ready for testing by spring of next year.

Cryogenic Rotor Test Started

A mushroom-shaped rotor soon will be set spinning while balanced in a superconductive magnetic field at the University of Miami's J. Neville McArthur Cryogenic Lab. The lead-coated aluminum rotor spin experiment may result in more precise gyros and reaction wheels used to absorb flight shocks in space vehicles. Helium gas will be used to start the motion, and a radioactive trace method will track the revolutions.

Five-Ligand Chelate Lases

A five-ligand chelate solution, an organic adduct of piperidine and europium benzoylacetonate (PBA), has been lased by Electro-Optical Systems, Inc. Dissolved in alcohol and lowered to —150°C, the chelate showed laser action at 6,130 Å, with thresholds near 1,800 joules. EOS now is studying the structure of the PBA molecule to extend the five-ligand technique. By use of energy transfer from a molecule such as benzophenone, the company hopes to lase chelates of this type at room temperatures. Work on the PBA compound was carried out under contract with the Air Force Systems Command.

Biax Memory Gives 10-mc Readout

A 1,024-word Biax memory with a 10-mc read-rate is being marketed by Aeronutronic division, Philco Corporation. Main application is in large data-processing computers, but a miniaturized version could be used as a content-addressable memory in a surveillance satellite. Such a memory could scan large amounts of incoming data and select appropriate items for discard, storage, or transmission direct to a ground station. "Microbiax", a ferrite memory with about one fifth the Biax volume, may be available from Aeronutronic by mid-1964. Used with integrated circuits, a unit small enough for satellites is feasible. Aeronutronic expects to market a memory with a 20-mc read rate within two years.

MATERIALS

Boron, Beryllium Monitors Developed

Two new devices for the detection of harmful amounts of poisonous boron and beryllium compounds have been perfected by researchers at IIT Research Institute under Air Force sponsorship. The boron monitor is based on the characteristic flame color present when boron contaminants are burned. A photomultiplier measures the color intensity and trips alarms when the readings reach a pre-set point. The beryllium monitor bombards airborne dust samples with alpha rays. Gamma rays result from the nuclear reaction of alpha particles and beryllium. The boron monitor will sense the safety level of 10 parts per billion parts of air and the beryllium monitor sensitivity is as low as two micrograms of beryllium dust per cubic yard of air.

PROPULSION

Pivotless Gimbals For Rocket Engines

Support of rocket engines by gimball rings carried in cross-ring flexures has been suggested by F. A. Kaiser, Utica division, Bendix Corp. Advantages stem from the elimination of rubbing and rolling surfaces, thus avoiding need for lubrication and problems of vacuum-welding phenomena in space. By suitable design, a zero, negative, or positive spring rate can be achieved, as desired. Zero and negative rotational rates have been built into an 8,400-lb.-thrust prototype engine, successfully reducing the actuator forces needed to vector the engine.

Solids Tested for Space Aging

Investigations into the effects of prolonged exposure to both high vacuum and radiation on PBAA and polyurethane propellants indicate such fuels can take at least a year's storage in space without deleterious effects. After vacuum exposures of 6 to 10 months at 10^{-6} torr and radiation exposures equivalent to 1 to 10 years in the Van Allen Belt the researchers found a loss in plasticizer causing slight stiffening in the PBAA propellant, statistically significant but not appreciably degrading vacuum effects and changes due to several years radiation exposure that might adversely affect performance. Major radiation effects are cross linking in the PBAA and polymer degradation in the polyurethane.

Rocket Acoustical Damping Studied

Mechanical devices for supporting combustion oscillations in rocket engines will be investigated by Pratt & Whitney Aircraft under a $110,600 contract from NASA. The study includes a comprehensive analysis of various types of mechanical damping devices, with special emphasis on oxy-kerosene combustion at 1,000-psi. chamber pressures. P&W will apply principles found successful in their turbojet and ramjet development programs.

Rocketdyne Gets Phoenix Pact

Rocketdyne's Solid Rocket Division, McGregor, Tex., will develop the solid rocket motor for the Navy's new Phoenix missile under a $3.6-million contract from Hughes Aircraft. The air-to-air weapon system is designed for the operational TFX (F-111B) fighter aircraft. Rocketdyne will use their polybutadiene-binder Flaxadyne propellant.

NASA Laser Communications, Tracking Effort To Double in FY '64

by Michael Getler

CURRENT NASA LASER PROGRAMS*

NASA CENTER	SUBJECT	CONCEPT	CONTRACTOR (IF ANY)	FUNDING
Headquarters	Optical Communications Systems Study	Study is to identify the theoretical and/or fundamental limitations of the component parts of a coherent optical space communications system as well as to indicate the constraints imposed on such a system by the environment.	General Electric, Missile & Space Div.	$82,675
	MIROS (Modulation Inducing Retrodirective Optical Systems)	Develop techniques suitable for crosscoupling information being carried on two laser beams either completely passive or with the consumption of a minimum amount of power. Areas of investigation: Phenomenological Collection and Correlation, Theoretical Investigation, and Experimental Investigation.	Philco Scientific Laboratories Westinghouse Electric Corporation	104,258
	Laser Beam Steering	Conduct theoretical and experimental research program to investigate electro-optical techniques to permit electronically controlling the direction of propagation of a laser beam.	General Telephone and Electronics Laboratories	60,000
MSFC	Study of Propagation of Coherent Radiation at Visible or Near-Visible Wavelengths through the Atmosphere	Study the interaction of very narrow high-power beams of coherent optical radiation with the aerospace environment.	International Telephone and Telegraph Corp.	50,000
MSC	Study of Optical Tracking and Communication System Adaptable for Use on Manned Space Flights	Study of optical communication and ranging devices including the modulation of light beams, CW lasers, burst modulation and time compression of data for modulation of pulsed lasers, and solar-powered lasers.	Hughes Aircraft Company	
GSFC	Development of Laser for Optical Tracking System	Determine atmospheric transmission attenuation, effect of backscatter, and the laser energy requirements for operational deep-space tracking and space communications systems.		
	Develop Faster Tracking Facility for Tracking S–66 Satellite	Facility will provide highly accurate tracking equipment capable of carrying out planned laser experiments on the S–66 satellite.		
JPL	Lasers for Planetary Missions and Quantum Electronics	Find methods to apply optical and infrared frequencies to space communications, tracking and planetary radar. Study quantum electronics and atomic resonance phenomena to find new components applicable to space electronics.		

*Within OART's basic research program carried on in the Electrophysics Branch, there are five university grants currently under way which eventually may be helpful to the R&D effort in development of optical communications.

MIT—Investigating the basic physics of laser operation throughout the optical spectrum which includes far infrared, visible, and ultraviolet. One of the areas being especially emphasized is that of extreme frequency stability of the gas laser as a means of greatly increasing the precision in fundamental measurements such as the velocity of light, possible "ether" drift, and the use of frequency as a much more precise standard than a meter bar in measurements of length.

Stanford Univ.—Concentrating on lasers of extremely high pulse power, mostly in the solid-state category; using these powerful lasers for producing nonlinear effects in solids as a means of providing a better understanding of basic solid-state properties such as energy transfer, relaxation phenomena, and electron-ion and other coupling mechanisms in materials of electronic interest.

Columbia Univ.—Studying new intermediate or metastable states in atoms. Such states are important in determining whether laser action can be obtained, and they also shed light on energy transfer mechanisms within the atom when undergoing high excitation.

Johns Hopkins Univ.—Investigating energy levels of many of the rare-earth atoms when these are dispersed in a crystal lattice of a suitable host material. The rare-earth atoms are readily excited and emit in a rather narrow spectral band so that they are interesting candidates for laser operation.

Univ. of Michigan—Investigating the way in which a host crystal accepts or accommodates impurity atoms of electronic interest which are dispersed throughout the crystal lattice. These added atoms distort and strain the lattice in various ways and thus determine the electronic properties of the material.

THE BROAD NASA EFFORT to develop the potential of laser systems for space communications and tracking functions will double under the proposed Fiscal Year 1964 plan for advanced research in this area (see accompanying chart).

Expenditures of FY '64 funds by NASA centers and headquarters in support of both industry and in-house efforts is expected to reach at least $2 million. Though the total effort will be about twice the FY '63 outlay of just over $1 million, NASA's rapid in-house buildup will actually keep the out-of-house industry portion from doubling. However, the major portion of the new effort, about 60-70%, is still expected to go to industry.

Of the NASA centers involved in laser programs, the Marshall and Goddard Space Flight Centers will maintain the largest portions.

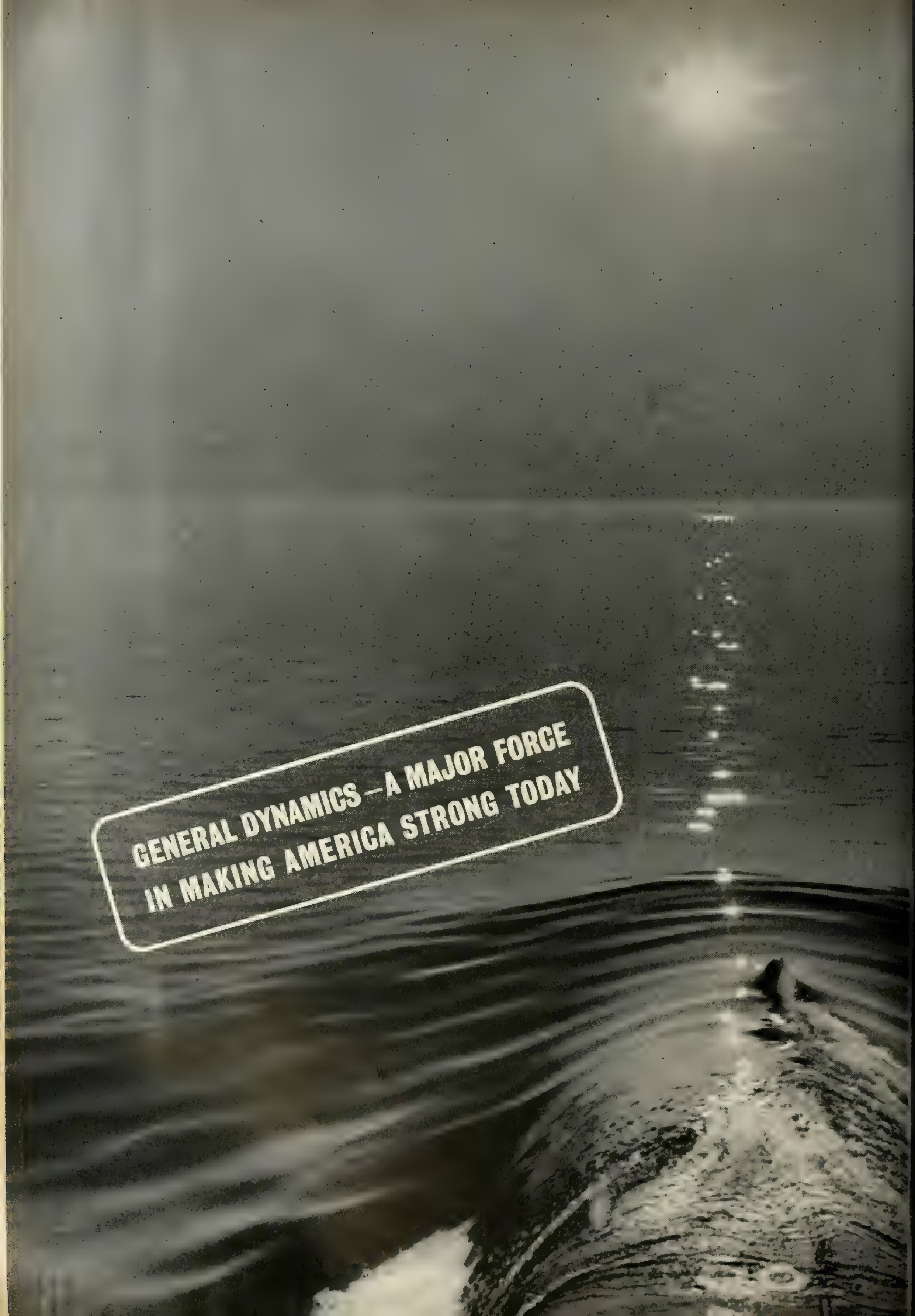
FY '64 activity and funding could be swollen somewhat if, in its desire to correlate and pursue basic laser needs throughout the space agency, NASA moves ahead, within the next few months, with a scheme to bring key scientists from several centers together to help draw up composite specifications on the type or types of lasers required. There could be a widespread development follow-on within industry.

Calendar 1964 will see the start of the highly important *S-66* satellite laser tracking program (M/R, Oct. 14, p. 9; Oct. 21, p. 29), though there is said to be still a slim chance that the launching will take place before this year ends. Also in '64, NASA hopes to lay the groundwork for a piggyback flight test of a *MIROS (Modulation Inducing Retrodirective Optical System)* over-the-horizon laser communications experiment. The space agency is also expected to pass judgment on the use aboard a *Gemini* spacecraft of a one-way space-to-ground laser communications system experiment now being developed by IBM (M/R, Oct. 14, p. 9).

Control over the entire space agency planning in this area, and liaison with the various centers and companies that participate, is centered within the Office of Advanced Research and Technology, Electronics and Control Directorate. Within the E&C offices, the communications and tracking section generates or coordinates the bulk of the studies and development programs; additional basic research is carried out within OART's Electrophysics Branch. ■

PROPOSED NASA FY '64 LASER PROGRAMS

NASA CENTER	SUBJECT	CONCEPT
Headquarters	MIROS	Continuation of FY '63 effort.
	Laser Techniques for Space Application	Determine the most appropriate techniques and components for application of lasers in space communications based on present state of the art.
	Precision High-Deflection Rate Laser Beam Steering	Develop an experimental electrically controlled laser beam deflector of a type suitable for use in high-precision automatic laser beam-tracking system application.
	Laser Beacon Tracking	Develop interferometric techniques to track laser beacons to within 0.1 second of angular arc of an optical axis.
	Laser Data Transmission Measurements	Theoretically and experimentally develop a mathematical model of the effect of the aerospace environment on the information being carried on a coherent optical beam and determine methods whereby any degrading parameter can be normalized out of the system operation.
GSFC	Quantum Electronic Devices	Investigation of basic laser parameters through the implementation of an experimental in-house breadboard laser communications system.
	Advance in State of the Art to Allow Laser Application to Long-Range Tracking and Telemetry	Continue development of laser ranging and tracking techniques; investigate the problems of laser technology which are pertinent to their ultimate use in space tracking, navigation and telemetry; develop lightweight optical retro-reflectors for precision tracking of spacecraft and Moon.
	Sensor Development for Laser Application	Develop sensors with high efficiency in the wavelength regions in which lasers appear to show the greatest promise for long-range tracking and telemetry and with response times compatible with transmission of wide-band information.
JPL	Quantum Electronics Research	Devise and study quantum electronic or related devices having potential future application to deep-space communications.
MSC	Development of Optical Deep-Space Communications System	Develop, evaluate and qualify for deep-space manned flights an optical or laser communication system capable of transmitting down TV, telemetry and voice signals.
MSFC	Research into Optical Superheterodyning Techniques	Investigate means of designing an optical superheterodyne communications receiver. Breadboard investigations are to be made with state-of-the-art lasers. From the laboratory investigations and theoretical studies, design guidelines suitable for engineering use should follow.
	Laser Demodulation and Photomixing Studies	Investigate various means of modulating and demodulating laser beams for space communications and guidance systems, and investigate photomixing techniques to be used in space guidance.
	High-Current, High-Speed Semiconductor Switch for Modulating Lasers	Frequency that injection lasers can be operated at is presently limited by the difficulties of forming the proper pulses for modulation. Objective of task is to develop a semiconductor switch capable of generating high-current, short-duration pulses for laser modulation.
	Research into Semiconductor Injection Laser	Further develop semiconductor injection lasers. Development of GaAs and GaAs-GaP injection lasers to a more practical state.
	Development of Narrow-Band, High-Efficiency Light Source for Laser Pump	Development of narrow-band, high-efficiency light sources as laser pumps; and research and development of other techniques of optical pumping.
FRC	Optical Instrumentation	Support the development of optical instrumentation to test experimental techniques for tracking, data-sensing and communications.
	Optical Tracking Techniques Investigation	Task will support an investigation to develop a technique useful in the design of future optical tracking systems.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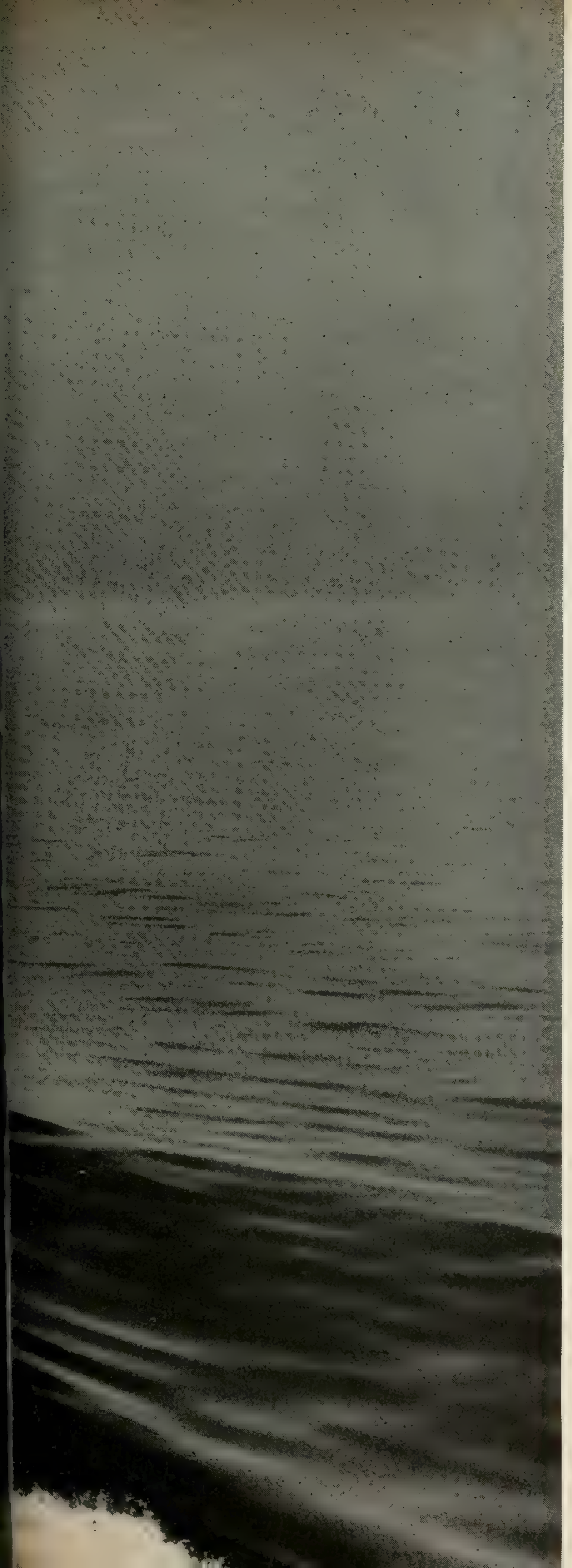

The nuclear-powered ballistic missile submarine, Alexander Hamilton, surfaces on a quiet evening sea.

The sea doesn't change:
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The United States Navy's first submarine, the Holland, could cruise underwater for 40 miles.

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The Electric Boat division of General Dynamics delivered the Holland in 1900.

And the first nuclear-powered submarine, the Nautilus, in 1954.

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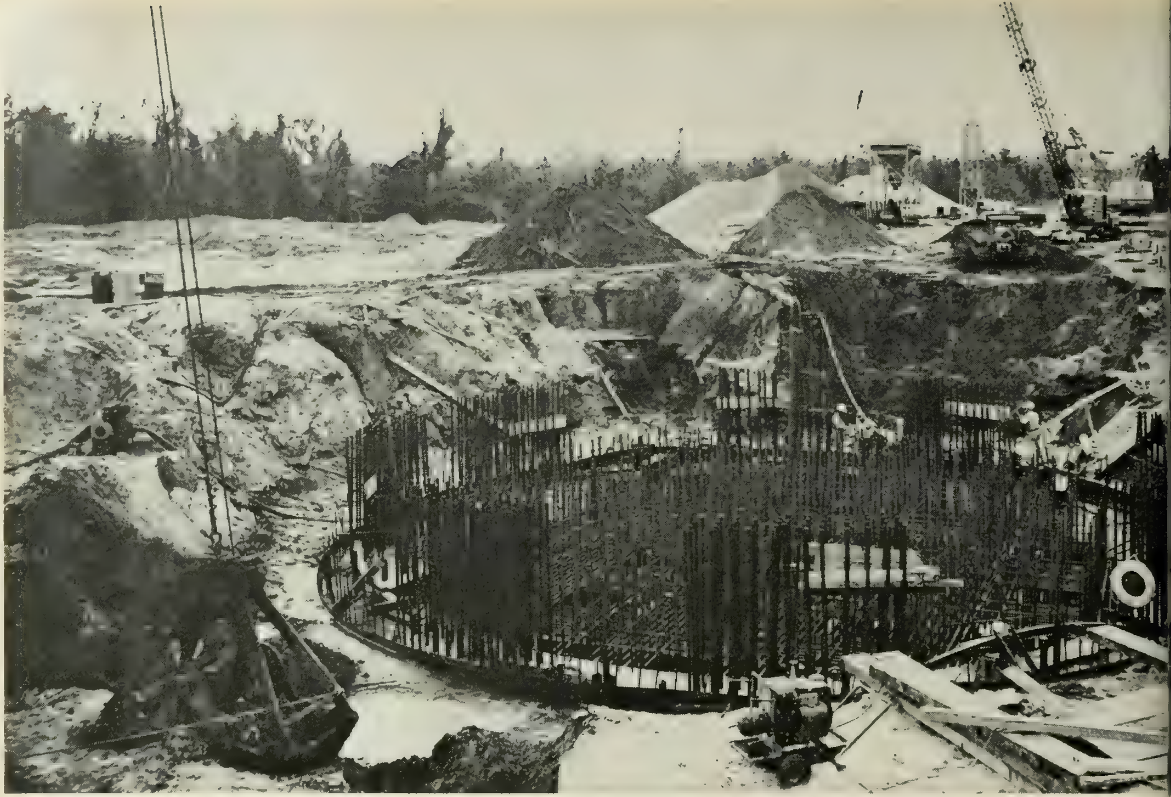


space propulsion

Thiokol's Space Booster Plant Takes Shape in Georgia

by John F. Judge

HORSE PEN BLUFF, GA.—Elements of a highly flexible, push-button solid-rocket plant are under construction here on a water-side tract surrounded by over 50,000 acres of uninhabited timber land.

Thiokol Chemical Corp. is pouring more than $12 million into the facility, which initially will handle Phases 1 and 2 of the Air Force/NASA Large Solid Booster Demonstration Program. The plant will be capable of processing over 70 million lbs. of propellant per year—somewhat more than is required for the demonstration program—with provisions for a smooth and economical expansion into full-scale production.

However, Thiokol planners are not definitely committed to any one production or processing method. The facility is designed to handle any of the newer processes now under active investigation.

The initial processing operation will use essentially the same batch-mixing methods employed at the Thiokol-operated Air Force Plant 78 in Utah for the *Minuteman* program. What difference exists stems mainly from the variance in motor size.

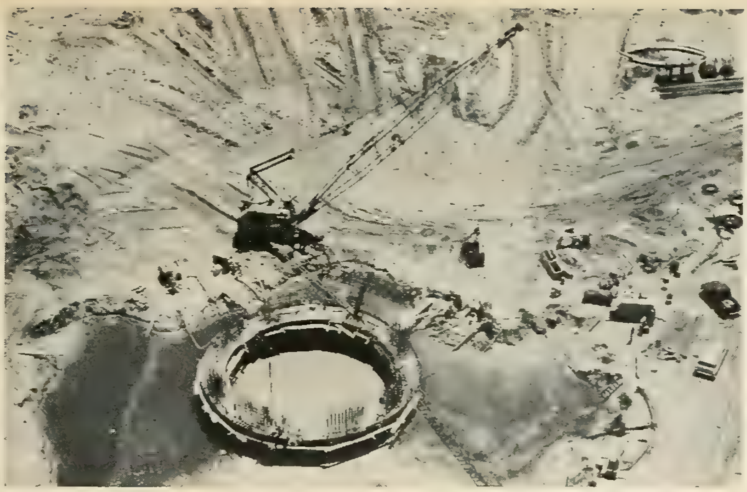
Many incidental improvements have been made in the new facility as a result of experiences in building and operating Plant 78. The Toledo Scale Automated Batch Weighing system (M/R, March 5, 1962, p. 36) will be part of the Camden County facility in Georgia.

• **Navigable transport routes**—The site has direct ocean access through a natural waterway providing a 14-ft. deep channel at high tides. It is in one of the least hurricane-affected sections of the Southeast coast. The plant proper is on high ground with deep bluffs fronting on the waterway. Cape Canaveral is 170 miles away via the Intercoastal Waterway.

The Space Booster Plant is part of the firm's Alpha Division, headed by vice president and general manager Joseph Wiggins. The plant manager is W. L. Berry.

Plant and process flow are planned by operations personnel drawn from the Huntsville, Ala., and Utah operations. Thus the facilities people will be the same ones who actually operate the completed plant.

The major innovation in solid-rocket processing technology is the combination casting pit and firing stand now



FAR LEFT: Thiokol's huge casting/firing pit during fabrication of reinforcing web. The entire mass was lowered to pit's bottom and concrete was poured under water shown in above aerial view. LOWER LEFT: Inert parts building stands next to large receiving dock on deep-water creek. Dockside water depth is 14 ft. at high tide.

nder construction at the Horse Pen Bluff site. The huge motor cases will be rocessed, loaded, cured and test-fired n the same facility. Each of the major irings in the demonstration program alls for about 3 million lbs. of thrust, ut the pit can handle many times this evel.

Thiokol is building with an eye to he follow-on portions of the AF/NASA rogram which will call for full-scale 260-in. units generating over 6 million bs. of thrust. While there will be many inor problems in moving through the rogram, Thiokol propulsion experts are onfident the large booster will be a uccess. This confidence is echoed in ther solid-oriented quarters—both government and industry.

When completed, the Space Booster lant will have a dozen operating facilities in addition to dock complexes. Two 00-gal. mixers will handle the demonstration program needs. Both have been odified to process 420 gallons at a ime by changing the design of the mixng bowls.

The process flow is designed to keep the mixers mixing. Details will be apparent in the process flow description. Temperature controls are set throughout the processing and proportioning steps to insure that all components arrive at the mixer ready for mixing—eliminating any delay in bringing the mixing batch to temperature while it is actually on the unit.

Proportioning and weigh-ups are programmed into the Toledo system, and there are built-in tolerance checks and overrides—as in the *Minuteman* production process.

- **Continuous by batch**—The oxidizer-preparation building has two gravity-fed microgrinders, each having a capacity of 2,000 lbs. The oxidizer moves pneumatically through the grinders and into the collectors. The flowing air dries the oxidizer.

The preparation facility has room for the addition of classifying equipment. Thiokol engineers are confident that the desired burning rate will be achieved in the demonstration program without such equipment.

There is no tie-in to the Toledo Automated Batch Weigh (ABW) system in this building. The oxidizer meets the paste in the weigh-up building.

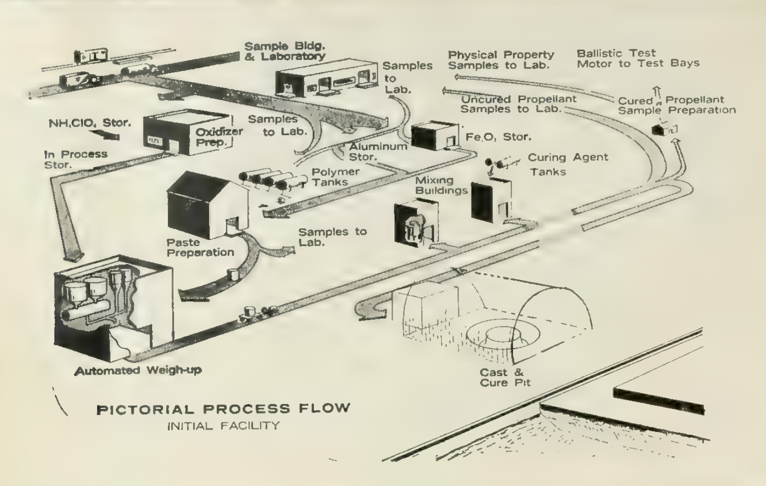
Four ingredients—two solids and two liquids—are prepared into a predetermined paste mixture. A 300-gal. mixer blends the polymer, aluminum powder, iron oxide and plasticizer after the separate components are added to a change can through the ABW system.

Apart from the Al powder, enough inert materials are stored at the paste-mix site to process 3.2 million lbs. of propellant. Thiokol likes to store its ingredients where they are to be used.

The Al powder is handled in 5,000-lb. tote cans, similar to the process in effect at Air Force Plant 78. There is a dual dumping system to assure continuous batch delivery.

The ingredients are proportioned into a change can automatically, using the ABW process. The system employs a gain-in-weight method, with the can resting on a scale and tared prior to any material delivery.

The first ingredient—probably polymer—is added to a preprogrammed



PICTORIAL PROCESS FLOW
INITIAL FACILITY

weight level. This weight—as are all ingredient add-ons—is double-checked. One scale measures material delivery; then a second checks the delivered weight against the predetermined figure.

Plasticizer is added to the can on a loss-in-weight basis through a separate scale because of the relatively small amount involved. The aluminum is added in the same manner as the polymer.

There is a 300-gal. mixer in the paste-mix facility. The mixer bowl is the same size as the main mixers, but its drive mechanism is smaller.

The can is moved to the mixer and the paste-mix operation commences. Iron oxide is added in a manner similar to the plasticizer addition during the mix cycle.

The paste can is then transferred to the automated weigh-up facility and dumped into a large surge tank.

• **Pre-mix processing**—The oxidizer delivery system in the weigh-up facility is again a dual dumping system. There is adequate room to install a completely pneumatic oxidizer delivery system for production purposes.

A pneumatic system utilizing heated air delivers the ground oxidizer fraction. This heated oxidizer is blended with the cold unground fraction, and the resultant temperature approximates that of the paste. The oxidizer is a loss-in-weight delivery to the blending system. The oxidizer blending proceeds for a programmed time period while the paste is being fed to the mixer bowl on a weigh platform. Again there is a double weight checking system. When paste addition is complete and checked, the blended oxidizer is added and the total is checked.

The proportioned batch is then moved to a surge hold area and kept at temperature prior to being attached to the 420-gal. vertical mixer. Half the mix cycle is run and the mixer is shut down. The blades are automatically indexed to avoid splatter and the curing agent is added. The mix cycle starts again and runs to completion. The mixed batch is moved to a surge hold area at the casting pit while quality assurance samples are taken. Thiokol waits until the last minute to add the curing agent, thus keeping the mix viscosity down during as much of the mix cycle as possible. This again allows the mixer to mix—not fight a progressively curing propellant.

• **Inert parts preparation**—After quality assurance frees the batch, the mix can moves to the casting pit. A hopper has been positioned on an elevator over the center of the prepared motor case. The mix can unloads the propellant into this hopper. The hopper feeds propellant to six tubes, or bayonets, which in turn move the propellant to the feed level within the case. Aeration slits de-aerate the propellant as it initially enters the tubes.

The massive half-length 260-in.-dia. maraging steel rocket case will arrive at the booster plant dock in a unique shipping container. The major inspection procedures will have been performed by Thiokol at the case vendor's plant. Only shipping damage will be checked at the dock.

The case, shell and all, will be transferred and lowered into the pit to a depth which leaves the aft end at ground level. When the case and its multipurpose handling shell are in position, a tool pole will be run down the center and anchored in the base pit fixturing. All case preparation operations will be run from this tool pole.

A circular work platform fits aroun the pole. The upper guard rails on th platform also serve as tubing for degreasing compounds. Nozzles on thes rails permit the platform to be used a a spray head to completely clean th inside of the case.

Ventilating equipment will be hooke to the shell to handle fumes and blov fresh air through the case and shell complex. After cleaning and inspection, th insulation process begins. Forward insulation and side liners are installed, an once again the work platform acts as spray head to apply the final liner coa

The work platform is finally removed from the tool column after fina insulation inspection and coating. specially designed mandrel is then fitte over the tool pole in an operation whic also sees to the sealing of the forwar end at the bottom of the pit.

Hot air is then forced through th handling shell, essentially converting to a massive curing oven. The castin operation is ready to begin once the system reaches the casting temperature.

• **Barometric casting**—Thiokol ha developed this loading method by combining bayonet and vacuum castin techniques. Prior to the admission c propellant, a vacuum is pulled on eac bayonet leg. Propellant is valved int this evacuated tube to its end, wher another valve flows propellant into th case. The propellant head in the le overcomes the differential pressur caused by the growing propellant mas in the case. Sensing devices inside an outside each leg check propellar heights.

As the case is filled, the bayone are drawn toward the top. Each six fee of propellant rise is handled by shuttin down the system and disengaging a 6-f section of the bayonet feed tubes, pul ing a vacuum and again adding prope lant.

Thus the hopper feed elevator system never travels more than six fee The process will continue until the propellant has been poured to depth—ther is no grain machining.

The huge casting pit is 120 ft. dee in work area and about 52 ft. in diameter. The pit is now near completio Initially, a massive cutting ring wa driven a short distance into the eart and sections of the pit wall progressive built on the cutting edge. The weigh drove the edge down to the designe depth. When the walls were secure, reinforcing mat was fabricated at th top of the pit and then lowered to th bottom. The pit itself remained full water and mud during all phases of th construction program.

With the reinforcing mat in plac the concrete bottom of the pit wa poured under water. The water wa then pumped out.

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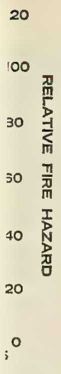

week in a facility closely matching NASA's study specifications for a manned orbiting research laboratory.

The 30-day, four-man space station simulation was the first run in a $350,000, two-module chamber installed inside one of General Electric's giant vacuum and space chambers at Valley Forge. The 12½-ft.-dia. by 22-ft.-high "space ship" only coincidentally matches NASA's recent study specifications, since design began before NASA announced its plans. The equipment and test was paid for with company funds.

● **Environment checked**—Objective of the test was to check out the new test facility and gather basic data on the physiological and psychological requirements and capabilities of men in space station conditions. Another major objective was to study the effects of a 7-psi, 50/50 oxygen-nitrogen environment for the 30-day duration. Oxygen partial pressure was maintained at 180 ±5 mm Hg, and total pressure at 360 ±10 mm Hg.

General Electric scientist F. A. Parker told MISSILES AND ROCKETS that this pressure was selected because it would eliminate almost all danger of emergency conditions. Parker pointed out that 7 psi has an advantage over 14.5 psi in this respect since danger of aeroembolism increases if the decompression ratio is more than two to one, and spacesuits for mobility's sake probably will be designed at about 3.5 psi.

The acid test of the atmosphere was made several days before the test started, when a case of St. Elmo's fire occurred in a piece of commercially designed TV equipment. It was observed that while the high oxygen content in the air helped to support the fire, the presence of nitrogen permitted it to be extinguished easily, GE engineers said.

● **No contaminants**—GE engineers point with pride to the fact that there were no cases of out-gassing or contamination by equipment or materials in the 1,500-cu.-ft. cabin. In fact, while activated charcoal and a bed of Hopcalite (a chemical mixture containing copper oxide) were provided to remove trace contaminants and carbon monoxide, respectively, neither had to be used.

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Four GE employees with an average of 10 years of engineering experience in addition to past aircraft or submarine service and able to pass stringent

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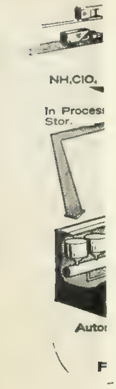

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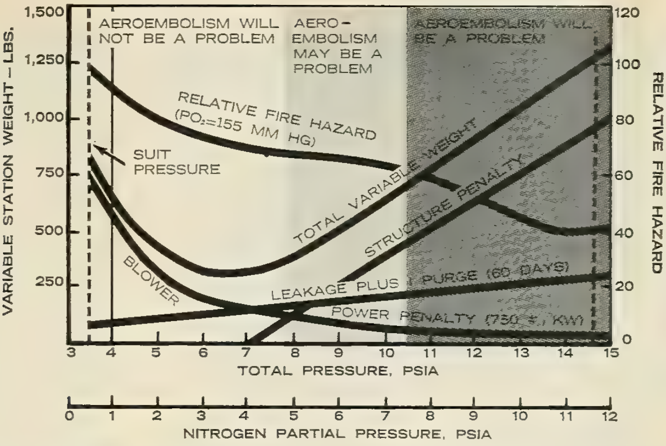

HART AT RIGHT shows effects of tmospheric pressure on subjects in a imulated four-man orbiting research lab-ratory. GE test was conducted with pres-ure at 7 psi.

space medicine

GE Test Simulates Orbiting Lab

Multiple aims of experiment included checking effects of 50/50 oxygen-nitrogen environment

by Heather M. David

VALLEY FORGE, PA.—One of the nost detailed space station simulations et conducted was completed here last veek in a facility closely matching JASA's study specifications for a nanned orbiting research laboratory.

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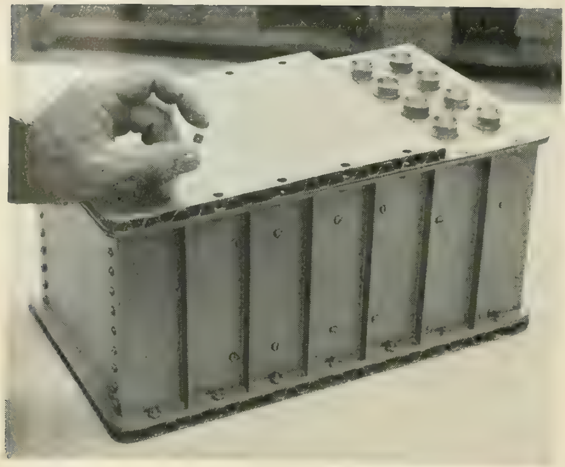

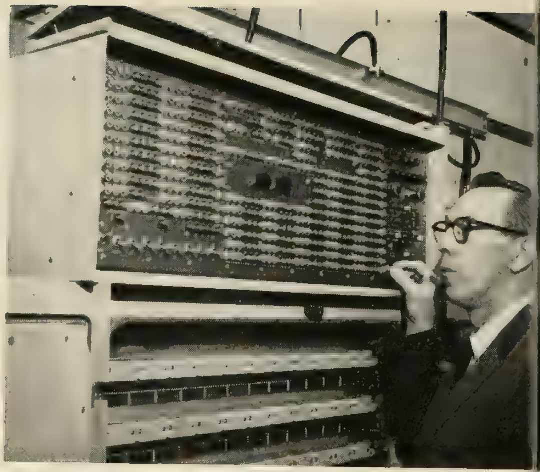

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physical and psychological examinations were chosen to be the first GE "terrenauts."

• Results—Extremely detailed medical studies were and are still being performed on the four crew members by physicians at Temple University Hospital. While only preliminary results are available, these conclusions were reached:

—All but one subject increased slightly in weight. The other lost approximately 11 lbs., but purposely dieted.

—There was a slight decrease in diastolic blood pressure.

—Electrocardiogram, phonocardiogram and carotid measurements were normal. Equipment to make these measurements was provided in the cabin and maintained by the men themselves.

—There were slight increases in blood calcium and BUN (Blood Urea Nitrogen), and a decrease in sodium. The men were trained to take intravenous samples of their own blood during the run.

—There were initial decreases in vital capacity, timed vital capacity and maximum breathing capacity, and no changes in oxygen consumption, tidal air, respiratory rate, inspiration reserve or expiration reserve.

—There was no change in calcium balance and an initially negative change in nitrogen balance.

—Urine measurements showed no change in pH and creatinine and an initial increase in sodium. There was a decrease in volume.

An interesting occurrence was that one man came down with an intestinal virus after three weeks in the chamber—considered quite a long incubation period for this type of illness. It was feared that the other men would also become ill, but they had escaped it up until the end of the test. Post-flight studies of the water, cabin surfaces and the men will be made.

• Psychological results—While there were no overt personality conflicts, the subjects seemed to release some tension by directing aggression toward the test conductors. This followed the same pattern as in recent Air Force studies (M/R Nov. 11, p. 31). Group cohesiveness score was lowest at the second day, with an upward trend beyond that time. High fatigue was reported through the third day. There was no apparent degradation in motivation throughout the test.

• Tasks—The crew had very carefully planned mission-type tasks, such as monitoring control panels, communications, reconnaissance, rendezvous and docking, and systems management. These tasks were performed in the mission module, or upper half of the space station simulator.

In general, there was no degradation trend in the vigilance tasks, although the subjects reported them very boring at first. These consisted of matching lights which flashed at random on a large panel. Only one of the four had a slight degradation in reaction time, and all showed a slight improvement in eye-hand coordination.

The subjects performed very realistic reconnaissance tasks, in which they were to identify and "photograph" areas of potential interest (airfields, industrial complexes) on aerial maps which flashed on a screen for only 25-sec. periods. Two men worked as a team on these tasks, one identifying and the other manipulating the "camera." There was improvement in target detection, but no change in skill of photographing.

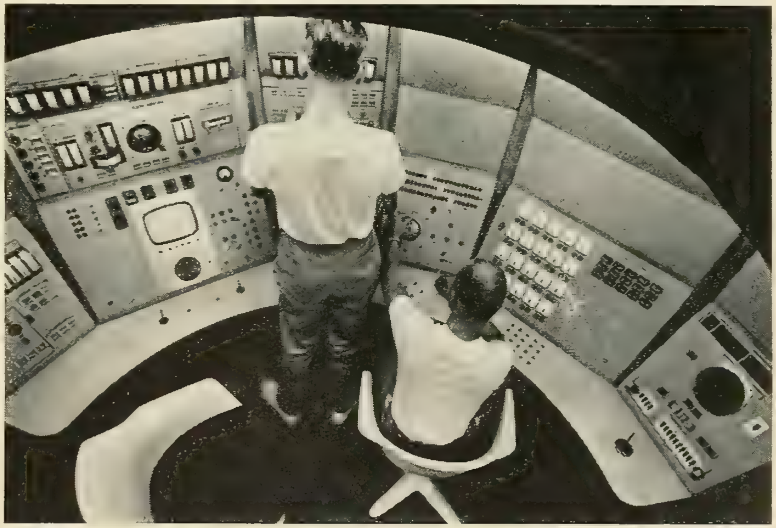
One of the most interesting tasks was a rendezvous and docking mission that employed a simulator in another area which was operated by controls in the mission module. The pilot was able to watch his operation on a TV screen. All flights were completed successfully, with improvement in the first 10 days. Three subjects had continued improvement after that, while one had a slight degradation.

The subjects concluded after the run that the two bunks in the living module should be sound/light-isolated. Since food preparation and recreation time were also spent in this area while one man was sleeping, this produced some irritation. They also suggested that the flight systems panels should be separated in the mission module.

• Food—Three-hundred lbs. of food was provided by Libby, McNeill and Libby. Most of this was freeze-dehydrated, needing only hot water to reconstitute it. Some tube food was included, but apparently found favor with only one man.

Menus included such items as juice, eggs, Canadian bacon and bread for breakfast; hash, beets, fruit and bread for lunch; and soup, lobster, tomatoes, potato puffs, and bread for dinner. The men were not required to stick to any diet or caloric intake, and calories consumed actually ranged from 800 to 5,000.

An average of 5 lbs. of water was consumed per man each day, in the preparation of meals and for drinking. Libby technical people also pointed out that the 7-psi pressure has an advantage over 5 psi in the preparation of this kind of food, since fairly hot water must be used.



FLIGHT DECK of space station simulator contains mission control instruments as well as special test devices to measure crew performance during 30-day test.

The subjects were observed continually by TV and movie cameras, and communicated with intercom and tape recorder. Almost constant communication was kept, in a simulation of the *Mercury* network.

Four random "failures" were programmed into the flight, and seven other minor actual failures occurred. Wiring diagrams of all equipment were provided the crew, but no other pre-instruction was given. The men were able to repair all items satisfactorily with standard tools and instruments.

• Future tests—GE hopes to use the cabin for a number of tests, the next one perhaps using a six-man crew. Advanced engineering director Richard A. Passman pointed out that the station can be modified to test flight hardware such as regenerative oxygen and water systems, space suits and other equipment. Another module could be built in the chamber. ■

ENGINEERS • SCIENTISTS

FOR THE NEXT BIG NEWS IN ROCKETS, LOOK TO NORTH JERSEY!

30 NEW R & D POSITIONS OPEN TODAY WITH THIOKOL REACTION MOTORS DIVISION

WORK ACROSS THE FIELD OF COMPACT LIQUID & HYBRID MOTORS, SPACE PROPULSION & POWER SYSTEMS

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- Hi-energy systems based on fluorinated oxidizers
- Advanced Systems utilizing thixotropic propellants, including materials and design research for appropriate thrust chambers, tankage, pumps, piping, nozzles, thrust and vector controls, ignition
- Space storable propellants
- ASW-deep-running torpedo propulsion systems for hunter-killer submarines
- Basic studies of combustion processes; characteristics of exotic materials, fuels

These positions are with THIOKOL's Reaction Motors Division in the New Jersey lake country at Denville, where R & D facilities include capability of producing full-scale prototypes and a test firing range.

Here, a young, wide-awake management is moving ahead in practically every phase of rocket technology, creating sophisticated engines of ever increasing efficiency to meet specialized space and weapons mission requirements. One famous achievement is the turbo rocket engine powering the X-15 aerospace vehicle...another is the packaged-liquid engine now in quantity production for Navy and Air Force Bullpup missiles.

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GAS DYNAMICS. Creative design of nozzles, two-phase flow systems involving chemical recombination. Translation of results into test programs. Advanced degree, minimum 5 years specialization in theoretical design and analysis of rocket engine nozzles

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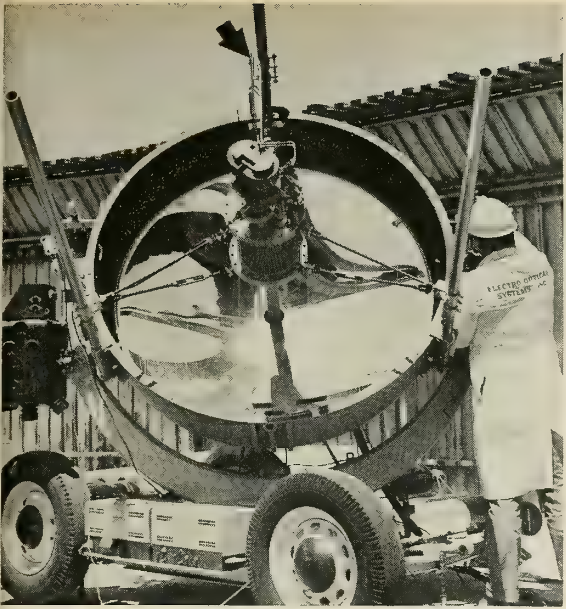
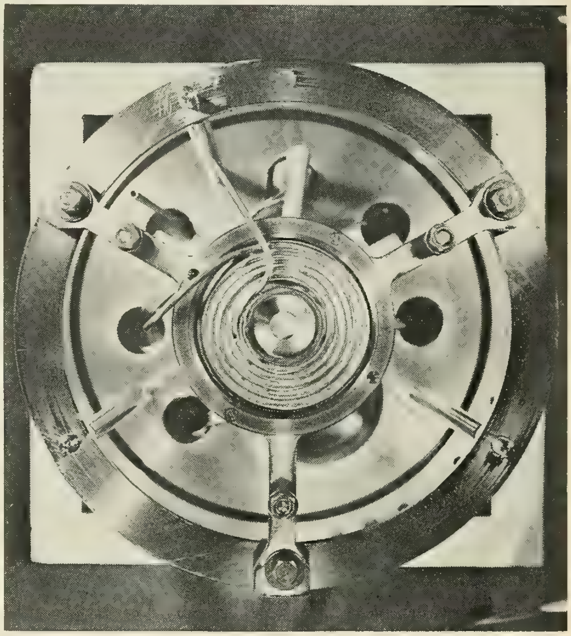
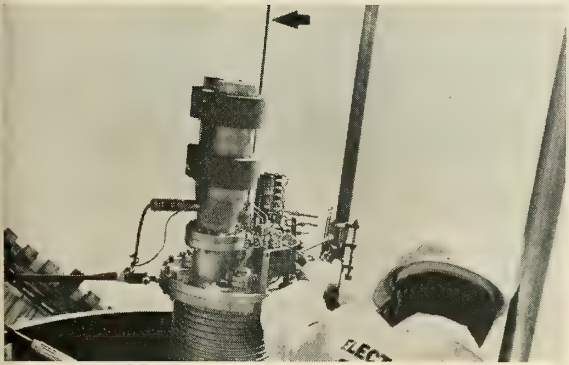


LEFT: SOHR propulsion unit is positioned at focal point of mirror. Arrow indicates nozzle.

BELOW: Heat exchanger mechanism for SOHR system receives solar radiation through aperture at center and absorbs the energy.





LEFT: Vacuum chamber used in successful test runs allowed solar energy penetration through small window in bottom. Arrow indicates hydrogen exhaust nozzle.

space propulsion

Sun Energizes EOS Hydrogen Engine

A SOLAR HYDROGEN rocket engine (SOHR) may be the key to synchronous satellite orbit transfer or continuous thrust for solar probes.

An experimental engine, designed and built by Electro-Optical Systems, Inc., demonstrated the potential of this approach in successful runs of several hours or more while generating up to a pound in thrust.

Sponsored by the U.S. Air Force's Rocket Propulsion Lab at Edwards AFB, the experimental program has now reached a point where scale-up to 10 lbs. thrust appears feasible.

The engine consists of large, lightweight solar concentrators which focus the sun's energy into a cavity absorber containing a hydrogen heat exchanger. The heated hydrogen is accelerated in a nozzle, providing thrust.

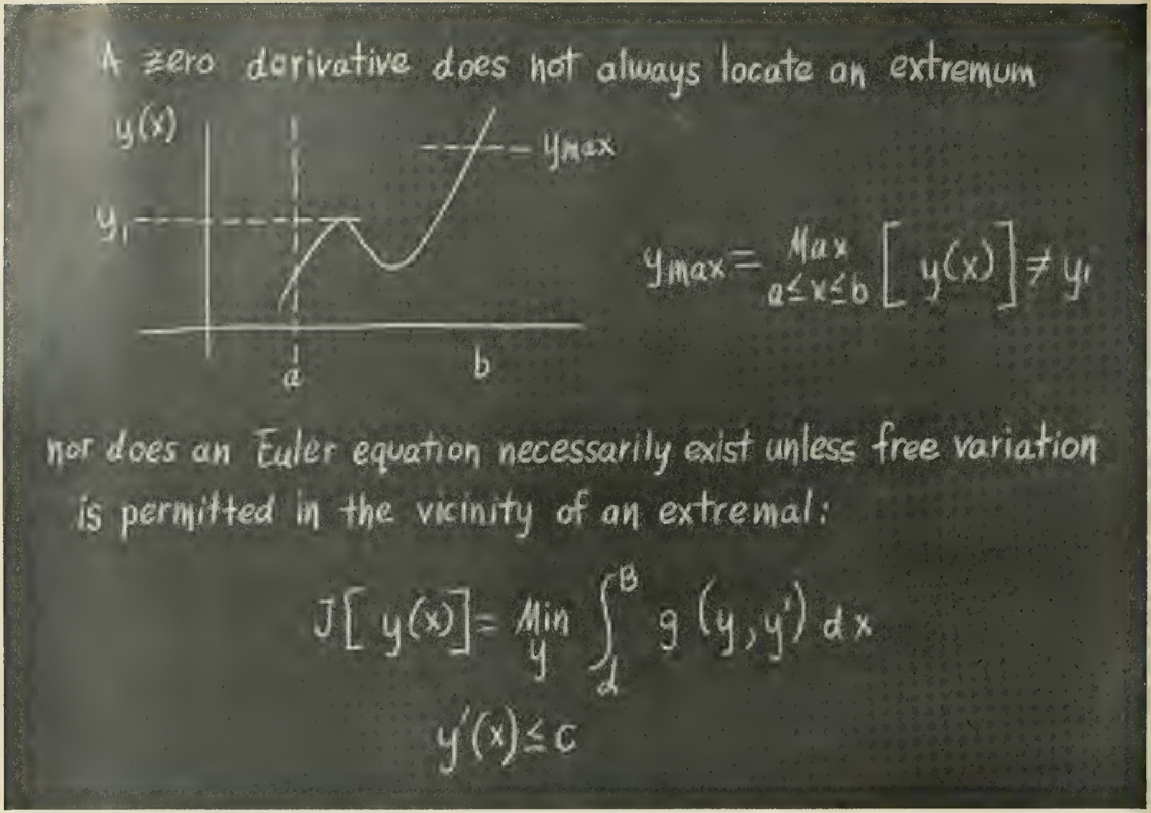
The specific impulse of the SOHR system is in the 800-second range, compared to 400 seconds for chemicals, 1,200 seconds for arc jets and 5,000 seconds and above for ion rockets.

An SOHR system generating 1-2 lbs. of thrust could move a payload with an initial gross weight of 6,000 lbs. from a 300-mile orbit to a 22,400-mile synchronous orbit in 20 days. Electrical units would take 45 days and a chemical powerplant could do it in 0.5 day.

EOS experts say the system could be in operation by 1966 and readily adaptable to the weight restrictions posed by the *Atlas-Agena* combination.

The lightweight reflectors might range in diameter from 5 to 40 ft. Their size is determined by the required thrust level. The EOS reflectors weigh about 0.4 lbs. per sq. ft. and have accuracies of less than 30 seconds of angular deviation in surface contour.

The aperture diameter is 1% of the mirror's diameter. The black body cavity encloses a refractory metal heat exchanger. Temperatures in the cavity range up to 4,000° R, with expected efficiencies up to 70% for the conversion of solar flux into gas enthalpy. ■


A zero derivative does not always locate an extremum
y(x)
y_max
y_1
$y_{max} = \underset{a \le x \le b}{Max}\left[y(x) \right] \neq y_1$
a
b
nor does an Euler equation necessarily exist unless free variation is permitted in the vicinity of an extremal:
$J[y(x)] = \underset{y}{Min} \int_{\alpha}^{B} g(y, y')\, dx$
$y'(x) \le c$

Nuclear scientists and engineers with an understanding of advanced engineering concepts are needed now at Douglas

One of the Douglas nuclear propulsion research projects now in progress explores the application of advanced optimization techniques such as dynamic programming, Pontrjagin's maximum principle and gradient methods, to the design of nuclear powered space vehicles. Currently there exist openings for experienced engineers and physicists (with advanced degrees) in projects like the above involving **Shielding / Core Design / Controls / Heat transfer / Vortex flows / Hydrodynamics / Thermionic-solid state devices / Hazards / Crossed field accelerators.** If interested, you are invited to contact our representative, Mr. A. Sander, during the American Nuclear Society meeting at the Statler Hilton Hotel in New York City from November 18th thru 21st. Telephone is CIrcle 5-2224. If this proves inconvenient, please write to Mr. W. S. Ames, Douglas Missile and Space Systems Division, 3000 Ocean Park Blvd., Santa Monica, California. An equal opportunity employer.

DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION

Mergers and Acquisitions

Shareholders of Clifton Precision Products Co., Philadelphia, will meet Nov. 29 to vote on the proposed sale of Clifton assets to Litton Industries, Inc., (M/R, Nov. 11, p. 39). Clifton shareholders have until that date to accept a Litton offer of $24.75 in Litton stock for each Clifton share. Offer is reduced to $20 after that time. Clifton directors have already agreed to the sale in principle, and the transaction is expected to be completed by Dec. 2. . . . *Epsco, Inc., Cambridge, Mass., has purchased for an undisclosed amount the "Bay State" product line of microwave signal generators from the Bay State Electronics Corp. Engineering and manufacturing of the generators will be integrated into Epsco's facilities.*

New Firms and Divisions

EMC Technology, Inc., has been formed in Philadelphia to develop, manufacture and market specialized electronic components and to engage in research and development in advanced technology areas. The firm also plans to seek R&D projects both from Government and industry. . . . *Multisonic Corp., Westbury, N.Y., has been organized as a wholly owned subsidiary of National-Standard Co., Niles, Mich., and has bought the inventory, plant, equipment and other operating assets of Sonic Systems, Inc. The new company will design, manufacture and distribute ultrasonic cleaning equipment and devices.* . . . The Inertial Navigation Div. of Autonetics Div., North American Aviation, Inc., has been renamed Navigation Systems Div. The change is said to better reflect the division's expanded activities and capabilities in navigation concepts involving such diverse technologies as lasers, radio, infrared and acoustics, both as individual equipment and as part of complete navigation systems.

Industry Facilities

High Voltage Engineering Corp., Burlington, Mass., has announced plans to construct a new accelerator research facility. The 20,000-sq.-ft. building will house a development program devoted to improving tandem Van de Graaff accelerator performance. Completion is expected by mid-1964. . . . *Telemetrics, Inc., Gardena, Calif., plans to move to a 42,000-sq.-ft. headquarters, engineering and manufacturing facility to be erected in Santa Ana, Calif. The move will provide a 140% increase over current space for the firm, manufacturer of telemetry systems for the missile/space field.* . . . General Electric Co.'s Re-entry Systems Dept., Anaheim, Calif., has installed a Ling L-200 shaker to expand its vibration laboratory capability. The laboratory is used to test entire re-entry vehicles, subsystems and components. . . . *Staff and facilities of Temec Div., Cubic Corp., have been transferred to a 32,000-sq.-ft. plant in San Diego, Calif. The facility, formerly Cubic headquarters, has been refurbished and equipped for Temec production of advanced tracking systems. The division was formerly located in Van Nuys, Calif.* . . . Space-General Corp.'s Manufacturing Div. has acquired a 12,300-sq.-ft. building in El Monte, Calif. The plant will be used initially for engineering and production of electronic equipment for AMR.

International

Under terms of the recent *Polaris* sales agreement between the U.S. and the United Kingdom, General Dynamics Corp.'s Electric Boat Div. will provide services for use in the British *Polaris* system. The U.K. will build its own vessels and install weapon systems manufactured in the U.S. . . . *North Atlantic Industries, Inc., Plainview, N.Y., has appointed Aveley Electric, Ltd., South Ockendon, Essex, exclusive sales representative for NA's electronic test equipment and servo systems in the United Kingdom.* . . . United Aircraft Corp.'s Hamilton Standard Div. has purchased world-wide rights to an electron beam welding and machining process originally developed by the Carl Zeiss Foundation, Oberkochen, West Germany. Machines for foreign distribution will be manufactured at Hamilton's Windsor Locks, Conn., facility. . . . *Deutsch Co., Banning, Calif., has opened a new facility in East Grindstead, England. Called Hellerman Deutsch, Ltd., the plant will manufacture and distribute electronic components to the European aircraft and missile/space industries. Deutsch also has facilities in the U.S., France and Germany.* . . . Garrett Manufacturing, Ltd., a subsidiary of the Garrett Corp., Los Angeles, has completed an agreement with the Canadian Government's Dept. of Industry for a research and development program to design a family of static inverters for the Canadian export market.

Company Representatives

Tenney Engineering, Inc., Union, N.J., has named Carey-Wolf Co., Fort Worth, Tex., sales representative for the southwestern states. Tenney designs and manufactures Earth and space environmental simulators. . . . *Brown Boveri Corp., New York, has named W. P. Keith Co., Pico Rivera, Calif., sales representative for southern California and Nevada. Keith will handle the BB line of induction furnaces.* . . . Sierra Electronics-Philco Corp., Menlo Park, Calif., has named three new sales representatives. They are: J & J Associates, Waltham, Mass., to cover the New England area; Scientific Sales Co., Chicago, to cover Illinois, Indiana, Wisconsin and Minnesota; and Gaine Engineering Co., Detroit, Mich., to cover Michigan. The firms are authorized to sell Sierra's line of electronic measuring and testing instruments. . . . *Industrial Instruments, Cedar Grove, N.J., has appointed Gentry Associates, Inc., sales representative for its line of electrical test equipment in Florida, Georgia and Alabama.*

SIDE-LOOKING RADAR SYSTEMS ANALYSTS

New programs at HUGHES are generating opportunities for Systems Analysts experienced in high-resolution data gathering, data transfer and data processing systems. Openings exist for Systems Engineers, Mathematicians and Physicists qualified in synthetic array radars, optical, and other data collection systems (IR, Electro-Optical, SIGINT and others). Assignments include:

Senior Systems Scientist with 20 years' electronic systems experience—at least 10 years relevant to side-looking radar systems. Applicants will be considered for important program management responsibilities. M. S. or Ph. D. degree required.

Senior Systems Analysts with 10 years' electronic systems experience—at least 5 years relevant to high-resolution systems pre-design and evaluation. Applicants will be considered for assignments in concept formulation; single and multi-sensor applications; data transmission, processing and interpretation; systems integration and performance evaluation. M. S. or Ph. D. required.

Systems Analysts with 5 years' experience in: detection of signals in noise, optimum filter theory, nonlinear signal processing, information theory, MTI and doppler systems analysis. B. S. or M. S. required.

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AIR FORCE

$9,000,000—**General Electric Co.**, Syracuse, N.Y., for continued engineering and management of an air weapons control system.

$5,300,000—**North American Aviation, Inc., Autonetics Div.**, Anaheim, Calif., for continued research and development on *Minuteman* ICBM guidance and control systems.

$4,200,000—**Raytheon Co.**, Lexington, Mass., for production of special electronics equipment.

$3,700,000—**Raytheon Co.**, Lexington, Mass., for work on a system for remote detection of missile launchings.

$3,600,000—**International Electric Corp.**, Paramus, N.J., for continued manufacture and delivery of electronic equipment.

$2,000,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for further production of *Agena* upperstages.

$1,500,000—**General Electric Co.**, Philadelphia, for continued research on ballistic missile systems.

$1,400,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for services at the Santa Cruz Island test base.

$534,503—**United Technology Center**, Sunnyvale, Calif., for an integrated research effort on high energy hybrid propellants.

$149,945—**Rocket Power, Inc.**, Mesa, Ariz., for a year's extension of effort covering a study of rocket engine exhaust products.

$121,458—**American Machine & Foundry Co.**, Santa Barbara, Calif., for in-service engineering supporting *Titan I* launcher and antenna elevator systems.

$118,740—**Ozark-Mahoning Co.**, Tulsa, Okla., for a synthesis of new fluorine-containing compounds.

ARMY

$1,900,000—**LFE Electronics Div. of Laboratory for Electronics, Inc.**, Boston, Mass., for various electronic equipment for the Army Electronics Materiel Agency.

$225,000—**Martin Co.**, Orlando, Fla., for space parts for the Missile Master air defense fire distribution system.

$217,000—**ITT Federal Laboratories**, San Fernando, Calif., for services and materials necessary to a study of infrared electronic countermeasures.

$154,301—**Northrop Corp.**, Newbury Park, Calif., for RP-76 target missile flight services.

$98,039—**Sperry Rand Corp., Microwave Electronics Div.**, Clearwater, Fla., for a 12-month study of C-band ferrite duplexers.

$84,290—**General Precision, Inc.**, Glendale, Calif., for a magnetic tape memory system.

NAVY

$5,900,000—**General Precision, Inc.**, Glendale, Calif., for fire control systems for submarines.

$1,800,000—**Chromcraft Corp.**, St. Louis, Mo., for rocket launchers.

$1,500,000—**ITT Corp., Data and Information Systems Div.**, Paramus, N.J., for computer programming services.

$1,500,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for planning and support of *Polaris* missile facility under construction at Bangor, Wash.

$1,090,000—**Babcock Electronics Corp.**, Costa Mesa, Calif., for the production of maintenance sets and specialized support equipment to be used in conjunction with target control systems developed by Babcock.

$98,685—**North American Aviation, Inc., Columbus, Ohio, Div.**, for a study to produce data for an advanced missile.

NASA

$20,000,000—**Bendix Field Engineering Corp.**, Owings Mills, Md., for operation of a hemispheric satellite tracking system.

$750,000—**IBM Corp., Federal Systems Div.**, Rockville, Md., for *Saturn IB* and *V* guidance computers and test sets.

$750,000—**IBM Corp., Federal Systems Div.**, Rockville, Md., for *Saturn IB* and *V* data adapters and tests.

$650,000—**Sylvania Electric Products, Inc., Sylvania Electronics Systems Div.**, Waltham, Mass., for continued work on optical and electronic equipment for use in a NASA observatory which will circle the earth in a 500-mile high orbit.

$315,995—**Ling-Temco-Vought, Inc.**, Dallas, Tex., for *Scout* vehicle logistics support program.

$177,160—**Walter V. Sterling, Inc.**, Claremont, Calif., for a reliability study and analysis of the *Pioneer* spacecraft.

$160,050—**American Bosch Arma Corp.**, Garden City, N.Y., for development and evaluation of a miniature high accuracy spherical gyro.

$153,214—**Thiokol Chemical Corp.**, Huntsville, Ala., for nine modified rocket motors.

$129,948—**Goodyear Aerospace Corp.**, Akron, Ohio, for rigidized inflatable solar energy concentrators.

$124,913—**Mechanical Projects, Inc.**, Poquoson, Va., for design, fabrication and installation of a four-stage stream ejector system.

$111,943—**General Electric Co., Missiles and Space Vehicles Div.**, Philadelphia, for forming aluminum for solar energy concentrators.

$99,000—**North American Aviation, Inc., Los Angeles Div.**, for development of new materials for *Saturn* booster fuel tanks.

INDUSTRY

$10,600,000—**Marquardt Corp.**, Van Nuys, Calif., from **Grumman Aircraft Engineering Corp.**, for the development of reaction control systems for Project *Apollo*.

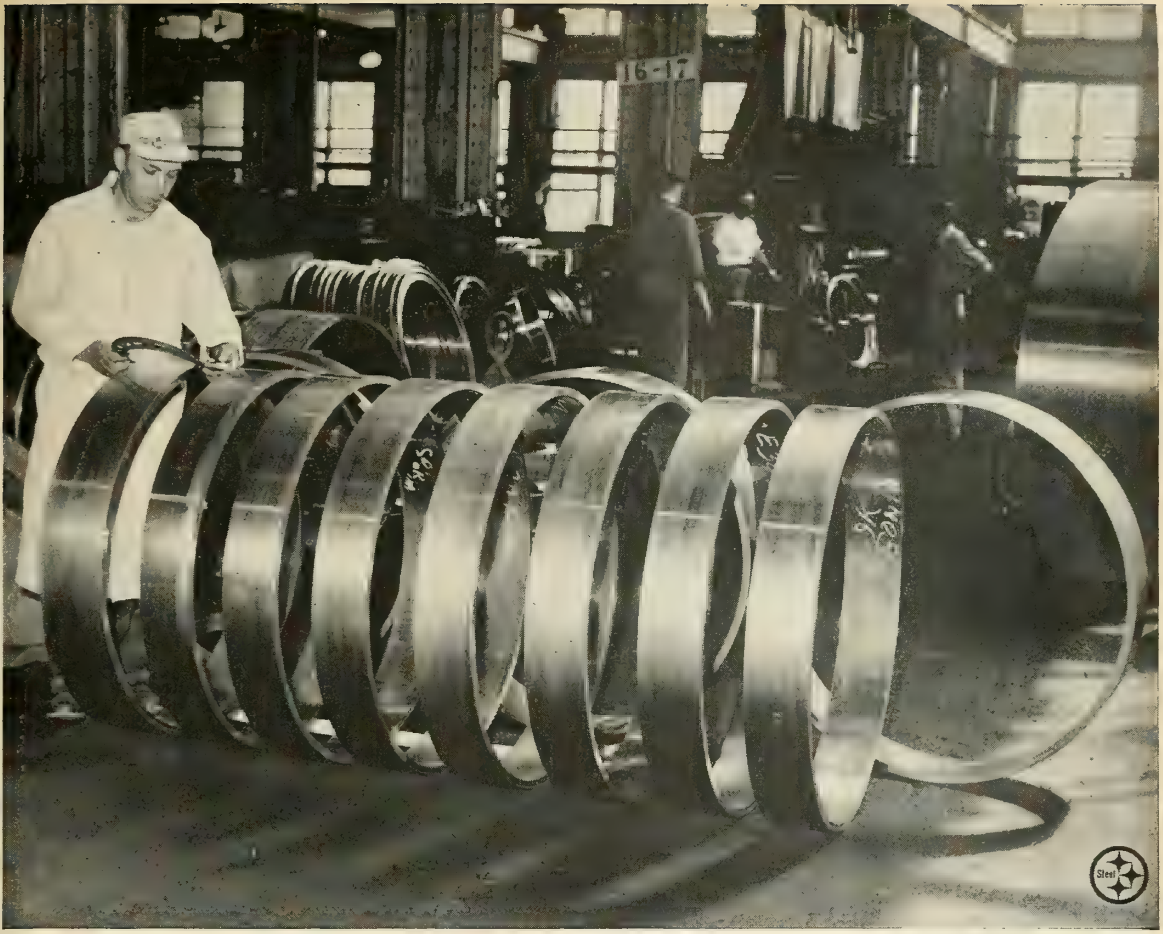
$3,600,000—**North American Aviation, Inc., Rocketdyne Div.**, Canoga Park, Calif., from **Hughes Aircraft Co.**, for development of the solid propellant motor for the *Phoenix* missile.

$1,650,000—**Fairchild Stratos Corp., Space Systems Div.**, Rockville, Md., from the **Martin Co.**, for a standard payload fairing which will protect payloads atop the *Titan III* standard space launch vehicle.

$60,000—**Cubic Corp., TEMEC Div.**, San Diego, from **Bendix Corp.**, for three pedestals and antenna systems for the Pacific Missile Range.

Kollsman Instrument Corp., New York City, from **Reflectone Electronics, Inc.**, for a *Sheridan Shillelagh* weapon system trainer visual subsystem (undisclosed amount).

Cook Electric Co., Morton Grove, Ill., from **General Dynamics/Astronautics**, for production of recoverable camera capsule systems to be used on *Centaur* space vehicles (undisclosed amount).



Forged rings of 18% nickel maraging steel ready for shear spinning into solid fuel rocket motor cases. (Made by Standard Steel Division, Baldwin-Lima-Hamilton Corporation.)

The answer to high strength lightweight rocket cases ...18% Nickel Maraging Steel

A steel with yield strength greater than 240,000 psi and fracture toughness sufficient for rocket motor cases! That's what metallurgists at Wright Aeronautical Division of Curtiss-Wright Corporation needed for their recent missile case development program. After a thorough investigation of the newly developed maraging steels in their laboratories, they selected 18% Nickel Maraging Steel for these highly stressed parts. And this quality nickel alloy steel fully met their requirements.

18% Nickel Maraging Steel sheet has a yield strength over 300,000 psi, good notched tensile strength, and Rc hardness 53-55. These mechanical properties are developed by a simple "maraging" (martensite-aging) treatment at 900 F for three hours. There is practically no *structural or dimensional distortion*—parts can be finished to close tolerances *before* maraging. Hot and cold working properties (before maraging) are excellent. So are machinability and weldability. And the steel has the unusual feature of also being readily weldable in the maraged condition.

Missile case designers at Wright Aeronautical Division found 18% Nickel Maraging Steel well suited for high strength lightweight motor cases...not only for present size rockets, but those envisioned for the future. Perhaps this remarkable maraging steel at either the 200,000, 250,000 or 300,000 psi yield strength level may answer your materials problems. For complete information about this new alloy steel, write for the booklet, "Preliminary Technical Data on the Maraging Nickel Steels."

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Nickel

...its contribution is

Quality

Circle No. 9 on Subscriber Service Card

New Product of the week:

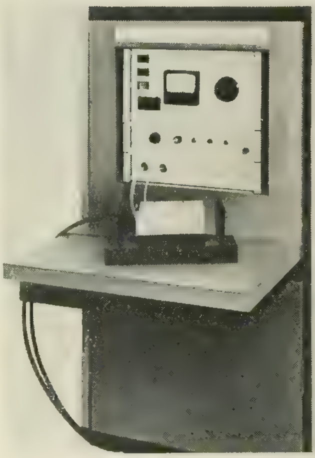
Laser Detector

The Model K-D1 detector, a power-sensitive photon radiation transducer for measuring and monitoring laser output, has been developed by Korad Corp. of Union Carbide Corp. The device can also serve as a trigger generator or demodulator.

The detector has a rise time of 0.3 nanosecond. Typical power measurements are from 1 to 10^{10} watts with typical energy from 10^{-3} to 10^{3} joules. The unit is available with either an S-20, S-4 or S-1 photo-surface, providing a spectral response range from 3,000 to 11,500 Å.

The unit may be illuminated directly or indirectly and is equipped with a bias network driven by a 2,500-v bias supply (optional).

Circle No. 225 on Subscriber Service Card



Molded Metal Film

A fully molded miniature metal film that measures 0.15 x 0.06 in. has been developed by Angstrohm Precision, Inc.

The units have a resistance range of 100 ohms to 100 k. Standard tolerance is 1%; tolerances as low as 0.1% are available. Power rating is 0.05 watt at 125°C. Temperature coefficients at 100, 50 and 25 ppm/°C are offered.

Circle No. 226 on Subscriber Service Card

Power Supplies

Electronic Research Associates, Inc., is marketing a line of all-silicon bench or relay rack-type power supplies.

Six models cover a 0 to 36-v dc range with maximum current ratings of 0 to 2, 2 dual, 4, 8 and 12 amperes. Input is 105 to 125v, 50 to 400 cps. Line regulation exceeds ±0.025% for full input and frequency change and load regulation is better than 0.05% for 0 to 100% load change.

Ripple is less than 1 millivolt RMS. The units are convection-cooled and may be operated at full ratings continuously up to 65°C. Temperature coefficient is less than 0.01% per degree C. Long-term stability exceeds 5 millivolts per 8 hours operation.

Circle No. 227 on Subscriber Service Card

Low-Level Transducers

Flow Technology, Inc., is marketing the "Milliflow Line" of low-level fluid flow measuring transducers.

The devices, capable of measuring both gases and liquids, allow for an in-line metering device, utilizing a bladed rotor to generate digital flow information. The generated pulses can be fed directly into digital totalizers; frequency to dc converters.

Overall liquid measurement capability of the complete line is from 0.005 to 5.0 gpm. Individual transducers measure any specified 10 to 1 range segment. Overall gas measurement capability is from 0.01 to 1.0 actual cu. ft./min. Range is any 8 to 1 segment. Accuracy is better than ± 0.25%.

Circle No. 228 on Subscriber Service Card

Hot Spot Indicator

A multiple hot spot indicator for use in temperature-sensitive areas is available from Pyrodyne, Inc.

The Model 225 "Temp-Plate" is an adhesive sticker containing a heat-sensitive compound. The white compound in the label turns black when the substrate surface reaches a pre-determined temperature. The rapid color change provides proof of temperature to an accuracy of 1%.

Temp-Plates are appliable to surfaces where selective heating occurs and the instrumentation engineer desires to know exactly the location and pattern of hot spots. Only those portions of the 2.75-sq.-in. area which have become overheated will cause color change in the sticker. As a result, a permanent record of heat distribution over the test surface is obtained.

Circle No. 229 on Subscriber Service Card

DC Transformer

A dc transformer, having properties similar to an ac transformer (voltage changes, magnetizing losses, behavior under load, constant efficiency, constant voltage ratio), has been developed by Micronia Amplifier Corp.

In place of the wound cores, Micronia uses capacitors and switches to obtain the same result. A circuit which incorporates these devices makes the voltage-transformation ratio independent of switching inaccuracies and capacity variations, providing an ideal tool for precise voltage measurements. It is already incorporated in a new digital voltmeter for accurate measurements of high voltages and is expected to find use in general d-c voltage calibration.

Circle No. 230 on Subscriber Service Card

Pressurization System

A pressurization/dehydration system, the Model PS-108, is being marketed by Eastern Industries. The unit features dual pressure outlets, with built-in air flow priority control, to satisfy high pressure volume (at 56 psia) before low pressure volume (18 psia).

The system operates in an ambient of up to 180°F with the air supply up to 100°F at altitudes up to 60,000 ft. Delivered air is dried to a −50°F dew point. The device has a capacity of 0.3 S.C.F.M. at 100% duty cycle.

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- Microwave Systems Analysis
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- Data Processing

INSTRUMENTATION ENGINEERS

- Flight Test
- Structures

If you have qualifications for one or more of the above fields, you may reply in confidence by filling in the coupon or writing to Mr. Gerald Caywood, Dept. MRA, The Boeing Company, Wichita, Kansas.

STRUCTURES ENGINEERS

- Structural Design
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- Vibrations/Flutter Analysis
- Stress Analysis
- Fatigue Analysis
- Weight Control
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A liquid level control for remote location is available from Omron Div., A&A Trading Corp. The Model TLF is designed with all components outside the tank and uses a transistorized proximity switch as its sensing device. The control box can be located up to 300 ft. from the vessel being maintained.

The unit has a reaction time of 30 to 40 milliseconds. Power supply is 115v and 230v ac. The control box contains a plug-in type relay DPDT—5 amperes at 230v and transistorized power amplifier. Temperature range is —10° to 45°C.

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Phase Meter

Acton Laboratories, Inc., has available a transistorized precision phase meter that provides automatic readout to accuracies of ±1.0° absolute.

The Model 329-A reads from 0° to 360° in 30° scales, with sensitivity and resolution exceeding 0.2°. Accuracy is maintained from 30 cps to 50 kc. The unit operates from inputs as low as 100 mv or up to 150v into a one megohm input impedance. "Plug-in packages" are available, extending input to a range of 1 mv to 1,000v, and giving the unit a precision phase shifter capability.

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Wideband Amplifier

Sperry Microwave Electronics Co. has available a fixed-tuned C-band amplifier.

The Model D61CO4 has a center frequency of 5,500 ± 50 mc and instantaneous bandwidths in excess of 115 mc when operating at 17 db minimum gain. Pump frequency is 17.5 gc with typical power requirement of 175 mw.

The device can be supplied with stabilizing heater jacket for use in severe environmental conditions. Waveguide switched circulators providing automatic and manual fail-safe operation are also available.

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Data Scanner

Auto Data, Inc., is marketing the Model 3100A, a 100-position, 4-pole scanner for medium speed signal selection applications.

The device can scan sequentially or be randomly programmed from tape or card readers. Specifications include an in-line 2-digit readout at a speed of 100 channels/second maximum. Power is 115v, 60cps. single phase.

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Pulse-Pattern Generator

Cybetronics, Inc., has developed the Model B Pulse-pattern Generator which utilizes ferro-magnetism for rapid programming of digital pulses.

Major element of the device is a magnetic peg board that controls 10 separate outputs, each with 64 serial bits individually selected by permanent-magnet plugs inserted in the board. Setting up or changing a program is accomplished by the arrangement of the magnets.

Triggering can be internal or external, with a maximum serial repetition rate exceeding 250 kc. Normal output levels are ground and —5v.

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Pressure Measuring Unit

A pneumatic pressure-measuring system available in ranges of 0 to 2,000 psia is being marketed by Litton Industries' Guidance and Control Systems Div.

The Model PC-4 uses unbonded train gage pressure sensors to supply measurement data to an analog computer. Accuracy is ±0.05% full scale and resolution is less than 0.01%. Bandwidths are to 15 cps. The unit meets MIL-E-5400 specifications.

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Vertical Gyroscope

A self-contained miniature vertical gyroscope has been developed by Electronic Specialty Co.

The Model NV5000 measures 3 in. in diameter and 4 in. long and weighs ½ lbs. The stainless steel device is vailable with synchro, resolver or potentiometer output signals. Gravity eference is maintained by built-in electrolytic switches, eliminating the need or external amplifiers.

Motor excitation is 3-phase, 400 cps, 15v; or 200 v RMS; or 28v dc.

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Picoammeter

Keithley Instruments, Inc., has developed a high-stability picoammeter with 20 full-scale ranges from 3 x 10^{-18} to 10^{-3} amperes.

The Model 409 has a zero drift of less than 1% per 24 hours on most ranges. Rise time is 1.5 seconds on the 10^{-12} ampere range. It has an accuracy of ±2% of full-scale on ranges u pto 10^{-8} ampere and ±4% beyond. Output is ±3v at 1 milliampere.

The device can be operated on 115 or 230v, 50 to 1,000 cps. Consumption 15 watts.

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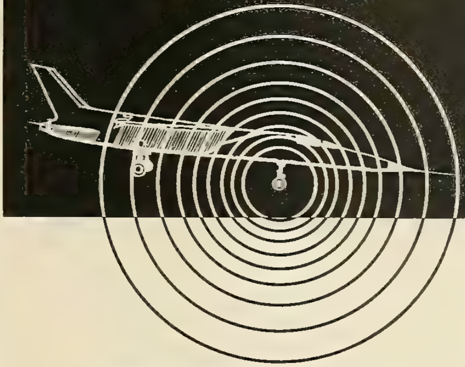
Mud in your nose-wheel steering?



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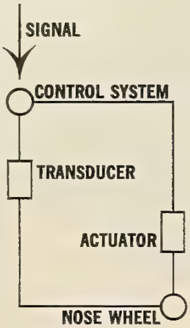

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Circle No. 11 on Subscriber Service Card

names in the news

Gerry M. Mills: Promoted to marketing manager of Centralab, the Electronics Div. of Globe-Union Inc., Milwaukee, Wis.

Dr. George W. Wertwijn: Appointed vice president and general manager of Scully-Anthony Corp., La Grange, Ill.

Nelson C. Harnois: Appointed vice president-marketing of Cubic Corp., San Diego, Calif.

Robert J. Hannon: Elected vice president of engineering for Anderson Laboratories, Inc., West Hartford, Conn.

Allen W. Osborne: Promoted to western regional sales manager for special products operations, Lansdale, Pa., division of the Philco Corp.

Thomas P. Matthews: Appointed national sales manager-OEM for Electronic Specialty Co., Los Angeles.

Stephen J. Tunkel: Appointed manager of the research engineering department, Reaction Motors Div., of Tihokol Chemical Corp., Denville, N.J.

Dr. George A. Albright: Appointed chief of space environment and life sciences at Republic Aviation Corp., Farmingdale, N.Y.

George E. Brown: Appointed controller and manager of administration of Super-Temp Corp., Santa Fe Springs, N.M.

Leonard Good: Appointed marketing manager for the Vacuum Products Div. of Varian Associates, Palo Alto, Calif.

Ronald C. Rayton: Named engineering manager for Tally Corp., Seattle. **W. L. Peterson** named production manager.

James M. McGowan: Named vice president-program management for General Precision, Inc.'s Link Div., Binghamton, N.Y.

Edward W. Sheridan: Joined Aerospace Corp. as assistant director of the operations engineering subdivision in the Engineering Div. of the El Segundo Technical Operations.

Dr. William M. Helvey: Named technical director of the newly-formed Lockheed Missiles & Space Co.'s bioastronautics organization, Sunnyvale, Calif.

John K. Wetherbee: Elected vice president-planning and engineering of Aeronca Manufacturing Corp., Middletown, Ohio.

Dr. Robert R. Bennett: Appointed vice president and director of advanced systems program management of TRW Space Technology Laboratories, Inc., Redondo Beach, Calif.

John Stonitsch: Appointed manufacturing manager for Fairchild Space and Defense Systems Div. of Fairchild Camera and Instrument Corp., Syosset, N.Y.

Fred T. Miller: Appointed director of program management for Moog Servocontrols, Inc., East Aurora, N.Y.

James S. Melton: Appointed manager of the Washington, D.C., office of General Motors' Defense Research Laboratories.

Paul G. Hendrickson: Appointed assistant to the vice president of Defense Electronics, Inc., Rockville, Md.

W. H. McGaw, Jr.: Named manager of advertising and promotion at General Dynamics/Astronautics, San Diego.

Robert G. Breckenridge: Appointed director of research at Union Carbide Research Institute, Tarrytown, N.Y.

Richard H. Nichols: Appointed assistant secretary of the Sparton Corp., Jackson, Mich. **Homer E. Welch** named assistant treasurer.

William W. Smith: Named project engineer for monopropellant systems at Rocket Research Corp., Seattle.

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NOVEMBER

Symposium on Unconventional Inertial Sensors, sponsored by Republic Aviation Corp., N.Y. Scientific and Technical Liaison Office, Air Force Systems Command's Research and Technology Div. and Bureau of Naval Weapons, Farmingdale, N.Y. (class.). Nov. 18-19.

Engineering in Medicine and Biology Conference, sponsored by AIEE, IRE and ISA, Lord Baltimore Hotel, Baltimore, Nov. 18-20.

Conference on Stratosphere-Metosphere Structure, sponsored by Texas Western College, American Meteorological Society and AIAA, El Paso, Tex., Nov. 19-21.

MAECON Symposium on Measurement and Instrumentation, sponsored by IEEE, Hotel Continental, Kansas City, Mo., Nov. 21.

Society for Nondestructive Testing Fifth Annual Symposium, Massachusetts Institute of Technology, Cambridge, Nov. 22-23.

International Council of Scientific Unions General Assembly, Vienna, Austria, Nov. 25-29.

DECEMBER

American Institute of Chemical Engineers Annual Meeting, Rice Hotel, Houston, Dec. 1-5.

Florida Aerospace Industry Seminar, Cherry Plaza Hotel, Orlando, Fla., Dec. 3-4.

33rd Symposium on Shock Vibration and Associated Environments, U.S. Naval Research Laboratory, Washington, D.C., Dec. 3-5 (confidential).

Electronic Industries Association Winter Conference, Los Angeles, Calif., Dec. 3-5.

Testing of Manned Flight Systems Conference, sponsored by AIAA and NASA's Flight Research Center, Edwards AFB, Calif., Dec. 4-6 (semi-classified).

IEEE Ultrasonic Engineering Symposium, Marriott Motor Hotel, Washington, D.C., Dec. 4-6.

IEEE 14th National Conference on Vehicular Communications, Adolphus Hotel, Dallas, Dec. 5-6.

International Symposium on the Stability of Polymers, Battelle Memorial Institute, Columbus, Ohio, Dec. 5-6.

IEEE Fourth Annual Seminar on the Reliability of Space Vehicles, Airport Marina Hotel, Los Angeles, Dec. 6.

Nobel Festivities and Nobel Prize Ceremony, Stockholm, Sweden, Dec. 10.

Electronics Industries Association Microelectronics Conference, Philadelphia, Dec. 10-11.

SAE Committee Meeting on Spacecraft Flight Controls, Houston, Dec. 11-13.

AIAA Conference on Heterogeneous Combustion, Biltmore Hotel, Palm Beach, Fla., Dec. 11-13.

National Vendors Meeting, Space and Flight Equipment Association, San Diego Aerospace Museum, San Diego, Calif., Dec. 13-14.

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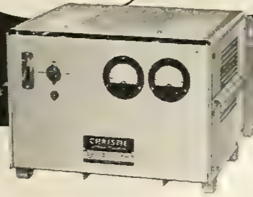

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The Goose and the Golden Egg

THOSE WHO COVET the space dollar are fond of suggesting, particularly before Congressional committees, that one of the most iniquitous things about the U.S. space program is its drain on scientific and technical manpower.

No figures are ever offered which support the charge, but usually it is implied that if top aerodynamicists and chemists were not concerned with such useless projects as developing the propellants and the vehicles to land men on the Moon, they might be engaged in more important pursuits—cancer research probably is the most often mentioned.

The fallacy of such reasoning seems self-evident, but it is gaining such widespread acceptance that a rebuttal appears necessary.

First, we would like to suggest that if all the scientific and technical manpower now in the space program were to be made available by the abrupt cancellation of that program, what the nation would have on its hands would be lot of unemployed scientific and technical manpower.

We have seen no evidence that the automotive, textile, oil and gas, metals, or ship-building industries are facing any crisis in scientific manpower—and the same can be said of medical research. Nor can we foresee any increase in R&D spending in these areas to employ this valuable manpower if it were turned loose from the missile/space industry.

Even were such an unlikely financial outlay to develop, manpower is not a commodity easily exchanged between industries, as the missile/space industry itself has found out. One need only look at the difficulty the production-oriented industrial complex of the Midwest has had in adjusting to the research and development requirements of the Space Age.

It should also be evident that a man is not usually just a chemist or an electronics engineer. He has inter-disciplinary interests and inter-disciplinary skills which have developed over the years and which guide him into specific channels. Eliminate the job of the chemist who is working on solid propellants and it is most unlikely that he will set out upon the chemical analysis of tissues which may contain a clue to cancer.

Just where does the demand exist for this scientific and technical manpower currently occupied in the space program? We would like to ask those noble servants who appear on the Hill and wail of shortage of trained manpower, just how many physicists and chemists they need, where they need them, and just which ones they want from this industry?

We would like to ask those who cry for space funds to spend on cancer research, just what sort of program they have in mind. Where specifically do they seek this cancer cure? Where, in a nation as rich as this one, is the specific program for cure of cancer which the Congress will not support without being first persuaded to cancel the space program?

Is the highly scientific and technical manpower of this industry to be put to work in the foreign aid program, school construction or slum clearance?

While the more highly trained members of the industry are engaged in such important tasks, what of those with lesser skills? Are they to join the current pool of four million unemployed?

There is indeed a shortage of skilled manpower in the nation, but let us look at it realistically rather than through the eyes of demagogues. The growing need for skilled workers—including those on the higher technical and scientific levels—exists against the background of a growing unemployment threat—an estimated national requirement for 34.5 million new jobs by 1970.

WHERE ARE THOSE JOBS to come from? If a solution is not found, unemployment can become the most staggering problem of this affluent society. New jobs develop from new technologies. And one of the fastest and most promising routes to development of new technologies lies in the missile/space industry.

With such a demand for new jobs ahead and with a concurrent need for skilled workers, the answer seems obvious—yet has received little attention. Training of surplus manpower to fit the requirements for skilled workers is the only sensible route—not a cutback in what soon will be the nation's largest industry. But we have yet to see any large-scale government program for training of unemployables.

Nor is it solely a government problem. It must be shared by the nation's industrial management and labor unions. And it is the missile/space industry which has been a leader in this regard. Plants going up in depressed areas, particularly in the South, will do much to bring jobs—and training—to those areas where they are most desperately needed.

Walter Heller, chairman of the Council of Economic Advisors, has said one of the critical aims of the nation's economic policy must be to open a wider range of economic opportunity in low-income states such as Mississippi.

Note should be taken, therefore, of what effect NASA's Mississippi Test Operations is expected to have on the nearby town of Picayune. According to the Chamber of Commerce, personal income is expected to increase by $15 million in the area, with employment at the NASA site reaching 5,700 by the end of 1964 and 7,300 in 1965.

Government and industry-sponsored research programs at the university level are doing much to interest and to develop the nation's next generation of scientists and researchers. Many of these programs are in basic research of benefit to all industry, not applied research of benefit only to the missile/space industry.

To those who assert that this industry is a heavy employer of the nation's skilled technical and scientific manpower, we say this is a blessing, not an evil. It is past time for this to be recognized.

William J. Coughlin

NOW—MONOPROPELLANT HYDRAZINE CONTROL ROCKETS

Pulse operation and multiple starts are now available with monopropellant hydrazine rocket engines. These Rocket Research Corporation engines utilize a revolutionary ambient temperature spontaneous catalyst produced by Shell Development Company, under NASA contract NAS 7-97, with technical direction by Caltech's Jet Propulsion Laboratory. The spontaneous Hydrazine Monopropellant System (SHMS) provides high-performance (delivered steady-state vacuum specific impulse of 235 seconds at an area ratio of 50, and 242 seconds at an area ratio of 100), wide temperature limits (+35° to 165F°), and requires no external ignition system or heat source . . . electrical or radioisotope heat not required . . . just open the propellant valve (one one per thrust chamber) and control thrust is instantly available.

Hydrazine, long noted for its safety and high performance as a monopropellant but heretofore lacking a catalyst to spontaneously initiate decomposition at ambient temperatures, possesses noteworthy advantages over its nearest monopropellant competitor, hydrogen peroxide, including:

- Ease of handling and storage (N_2H_4 systems are more compatable with tank and other materials than H_2O_2 and do not decompose with time).
- Less sensitive to contamination and dirt.
- Better thermal stability.
- Highest performance (30% theoretical, 50% actual at high area ratio by elimination of condensation losses present in H_2O_2 systems).

Specifically, monopropellant hydrazine control systems offer 20% to 30% weight savings over today's hydrogen peroxide systems.

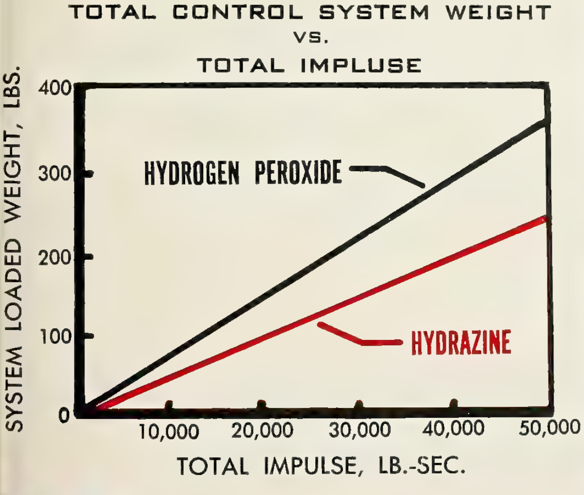
The graph below compares N_2H_4 and H_2O_2 for a typical 10 engine (four 50 pound thrust units, two 3 pound thrust units, and four 1.5 pound thrust units) attitude control system.

Further, monopropellant hydrazine systems should be considered as a replacement for higher performance storable bipropellant systems. Why? In addition to lower cost and development time, the overriding reason is higher reliability resulting from:

- System simplicity (one propellant tank, single pumping system, and reduced valving).
- Simplified injector (exact impingement of propellant streams for purposes of uniform mixing not necessary).
- High propellant utilization (no problem with mixture ratio control and temperature effects).
- Low thrust chamber heat transfer rates (radiation-cooled stainless steel or Haynes Alloy No. 25 chambers can be employed).
- Simplified field operations (only one propellant requires handling).
- Material and engine technology current state-of-the-art and demonstrated in flight hardware (no long term compatibility or corrosion problems).
- Easily throttled (only one component requires throttling, no mixture ratio control required, and injection characteristics not critical).
- Reliable restarts (spontaneous catalyst sequencing unimportant).

Monopropellant hydrazine engines can, therefore, fill a variety of needs from single start trajectory-correction to multiple start and/or throttling attitude control, rendezvous, station keeping, rocket belt, orbit trim, and docking applications.

Rocket Research Corporation can provide these units from 0.5 pounds to 500 pounds (or more) thrust with operating chamber pressures on the order of 100 or 150 psia (higher, if desired) and propellant feed pressures 115 to 120 psi above steady-state chamber pressure. Experience to date at RRC with monopropellant hydrazine engines has included the sea level engines shown below. The unit being held by Project Engineer Bill Smith, who was formerly with JPL as Project Engineer for the historic Mariner II Venus Probe Monopropellant Hydrazine Midcourse Propulsion System, is a five-pound thrust engine employing a Shell Development Company spontaneous catalyst. Also shown is a fifty-pound thrust hydrazine engine and, open to show its catalyst bed, an advanced design fifty-pound thrust hydrazine-hydrazine nitrate engine. This advanced design engine is indicative of the growth potential available from RRC's family of hydrazine engines; growth potential in the form of delivered vacuum specific impulses on the order of 260 seconds at an area ratio of 100 with a 2°F freezing point hydrazine-hydrazine nitrate system. Tell us about your requirements; we will be pleased to supply design details relating the new hydrazine control rockets to your specific program. Write, or call Bill Smith, 206-723-5166.



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Research Center. Naturally the scientific environment at the Sperry Rand Research Center includes a modern research facility, conducive surroundings, and advanced lab equipment. But research is people, not bricks, mortar and equipment. Sperry emphasizes this fact. ☐ The Center engages in basic research for Sperry Rand and others to provide a scientific foundation for future progress. Representing this research are (l-r) Dr. J. E. Shepherd, General Manager; Dr. Wayne W. Mount, Atmosphere Physics; Dr. Harold C. Mattraw, Chemistry; Dr. Roger Newman, Solid State Physics; Dr. Arvid Corneliussen, Applied Mechanics; Dr. Peter L. Auer, Plasma Physics, and Dr. Warren L. Semon, Applied Mathematics. They are supported by the full scientific talents of Sperry Rand Corp. *SPERRY RAND RESEARCH CENTER, Sudbury, Mass.*

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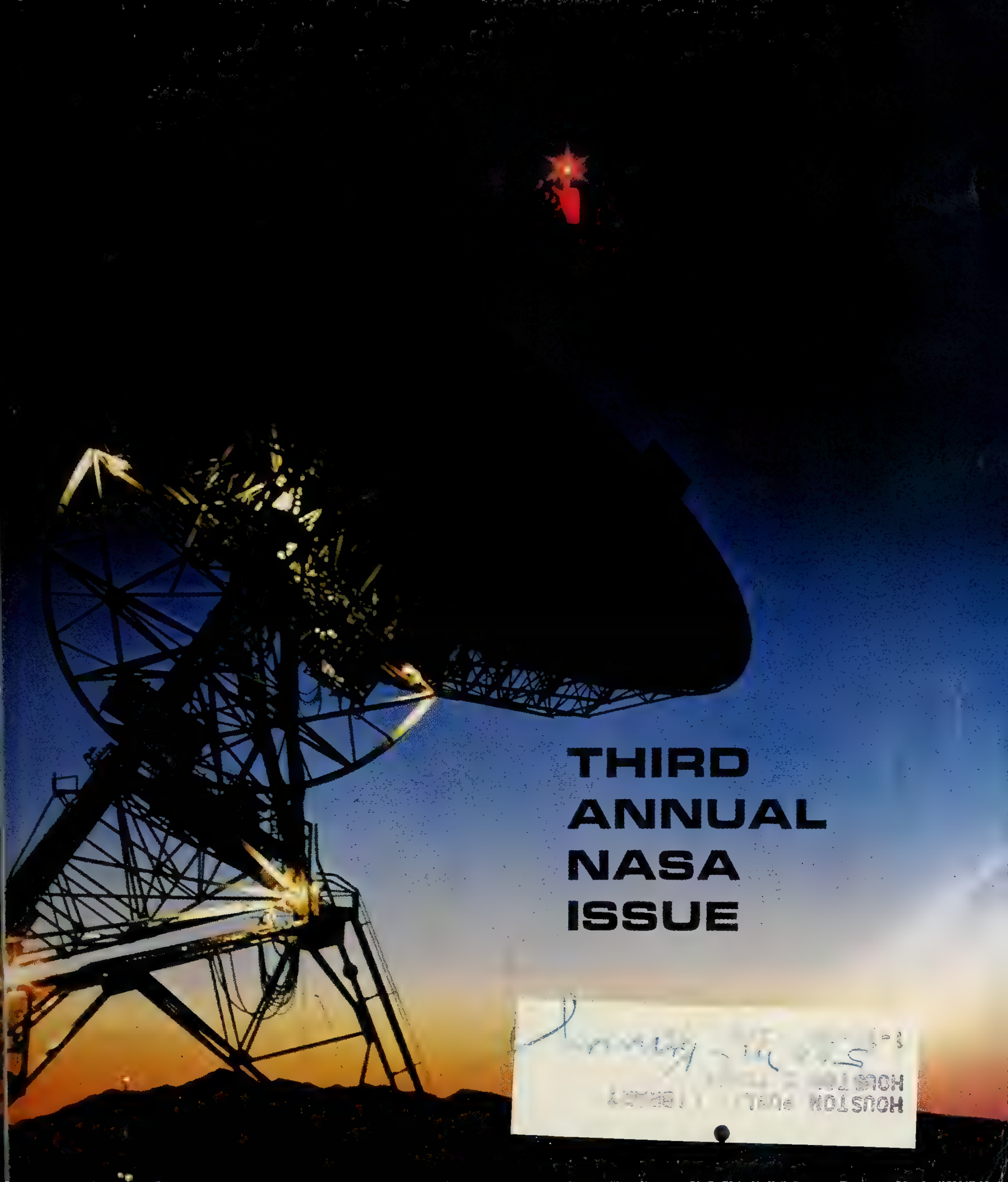
NOVEMBER 25, 1963

issiles and rockets

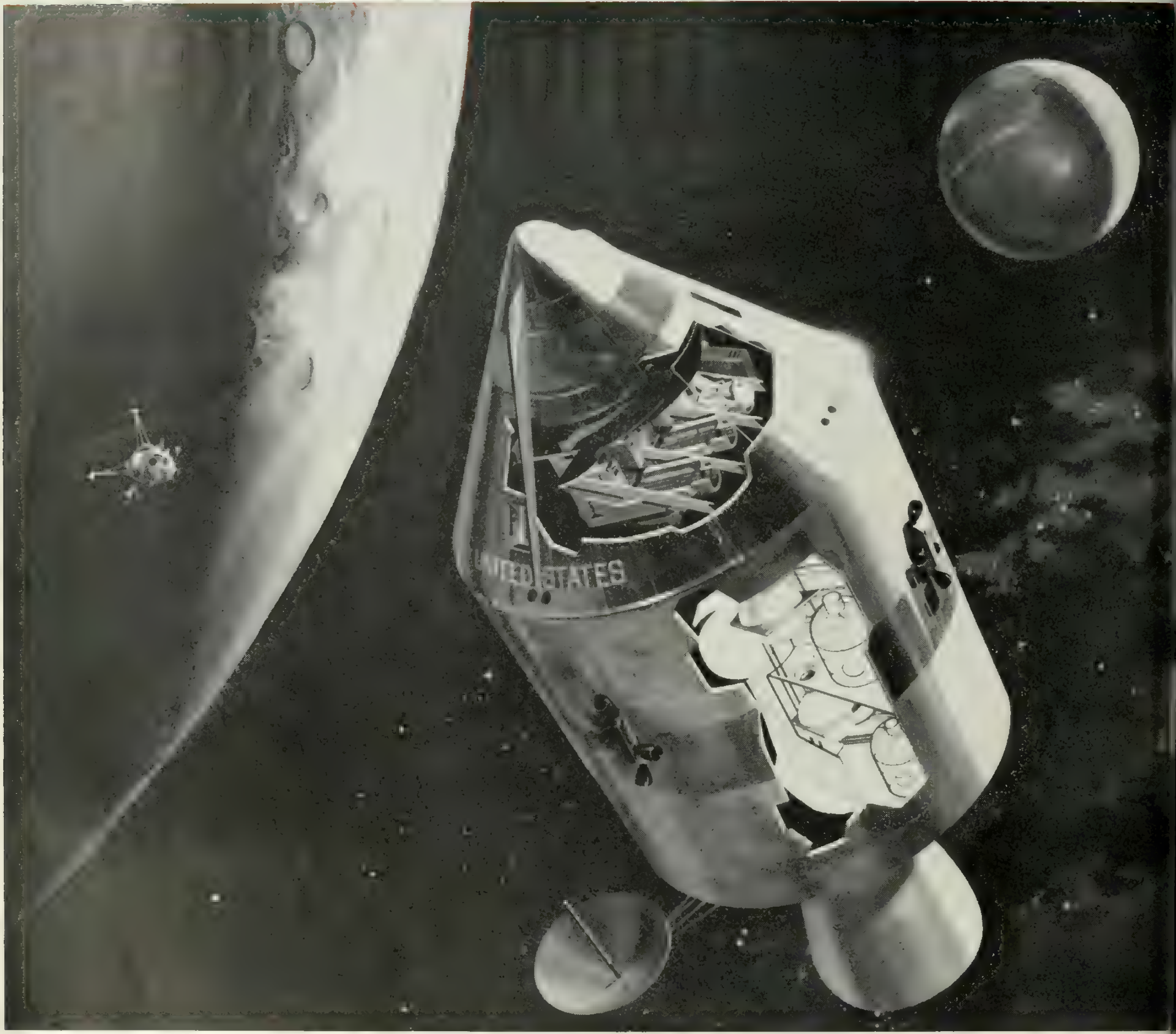
E WEEKLY OF SPACE SYSTEMS ENGINEERING



THIRD ANNUAL NASA ISSUE

Kennedy - 14 - 5

Beech *Imaginuity** in CRYOGENICS



Shirtsleeves environment in space: Beech's job for NASA's Project Apo

Beech selected to develop and build Cryogenic Storage Subsystem for life support and electrical power

When American Astronauts embark on their upcoming journey to the moon, they can doff their spacesuits and travel in a comfortable "shirtsleeves" atmosphere. Responsibility for the design, development, manufacture and testing of the storage systems to provide that atmosphere has been given to Beech by North American. The same systems will also supply the gases to generate power for the command module.

The selection of Beech for this vital task is based on solid accomplishment and proven reliab
pioneer in Cryogenics, Beech has been activ
design, development, manufacture and te
systems and sub-systems for many of our roc
missile programs.

A comprehensive physical facility has been
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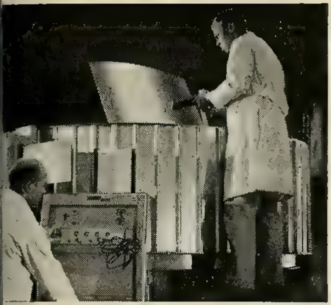

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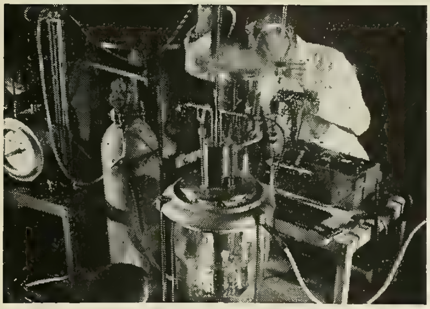

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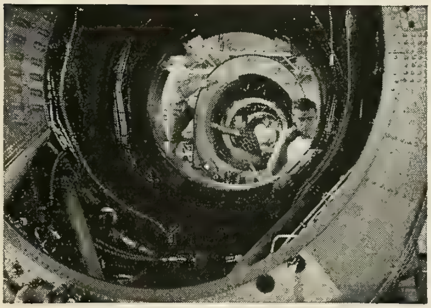

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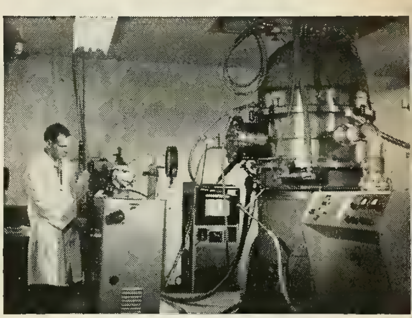

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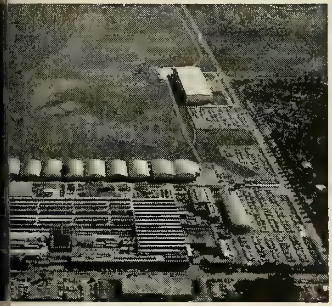

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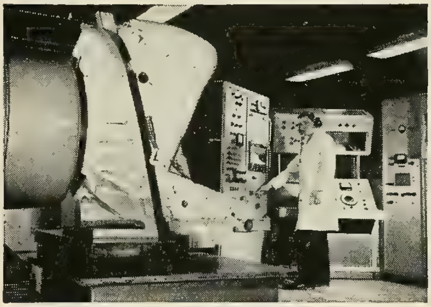

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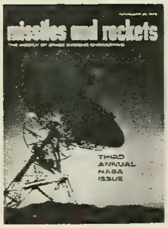

Huge radio telescope at NASA/JPL's Goldstone, Calif., facility has Blaw-Knox antenna silhouetted against sunrise. Tracking work at the telescope is intensifying as NASA moves into second phase of U.S. space program. M/R's Third Annual NASA issue begins on page 35. (NASA photo by Bill Taub.)

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18 field proved magnet designs

	Field Intensity	Inside Diameter	Winding Length	Field Uniformity	Operating Temperature	Outside Diameter	Overall Length	Delivery—Weeks
1	15,000	2"	4"	1%-½"	4.2°K	3"	6"	4
2	50,000	1"	5-½"	1%-1"	4.2°K	4"	8-¼"	7
3	15,000	2"	8"	0.1%-½"	4.2°K	3-½"	10-½"	4
4	50,000	1-⅛"	2-½"	10%-1"	4.2°K	4-⅝"	5-½"	7
5	30,000	½"	2-⅜"	1-½%-½"	4.2°K	2"	4-½"	4
6	30,000	2"	2-⅛"	6%-½"	4.2°K	4"	4-½"	7
7	50,000	½"	3"	1%-½"	4.2°K	3"	5-½"	4
8	15,000	1.4"	6"	0.15%-½"	4.2°K	2-¾"	8-½"	4
9	50,000	1"	4-¼"	2-½%-1"	4.2°K	3-⅞"	7-⅝"	7
10	50,000	1"	3-¼"	5%-1"	4.2°K	4-½"	6"	7
11	60,000	½"	3-¼"	1%-½"	4.2°K	3-¾"	5-⅞"	7
12	20,000	1"	11"	.05%-1"	4.2°K	2-½"	13-⅝"	7
13	8,000	½"	1-¾"	2-½%-½"	4.2°K	1-⅛"	4-13/64"	4
14	30,000	1"	2-¾"	12%-1"	4.2°K	2-47/64"	5-13/64"	7
15	50,000	1-⅛"	4"	2-¾%-1"	4.2°K	4-¼"	6-⅞"	7
16	50,000	1-½"	4-¾"	2%-1"	4.2°K	4-⅜"	7-25/32"	[illegible]
17	50,000	2"	4-3/16"	3%-1"	4.2°K	5-⅜"	6-25/32"	9
18	30,000	4.1"	9-½"	8%-4"	4.2°K	6-¼"	12-13/64"	12

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letters

G & C Issue

To the Editor:

Please accept our compliments on the excellent Oct. 7 issue of M/R, with its concentration of fine articles on guidance and control systems for missiles and spacecraft.

We are particularly pleased with the reference, in the Part III article on NASA systems, to horizon scanners developed by Advanced Technology Laboratories.

We do wish to point out that ATL is a division of American Radiator & Standard Sanitary Corporation, with its Aerospace Products Department located at division headquarters in Mountain View, Calif., rather than in Palo Alto, as noted in the article.

Betty Clinton
Advanced Technology Laboratories
American Radiator & Standard
Sanitary Corp.
Mountain View, Calif.

Victory Still Possible

To the Editor:

It is inconceivable to me that the people of the U.S. will accept a substitute goal for the exploration of the Moon by man at the earliest feasible time.

Russia has openly challenged the technological capacity of the United States and has punctuated her challenge by a series of historic firsts that are important in the eyes of the peoples of the world, the same peoples who will make the final choice between the two major systems of government in the world.

Russia took an early lead in the exploration of space because of the failure of the U.S. to properly evaluate rocket technology in the late '40's and '50's. Russia has kept the lead in manned exploration of space because of large-booster development that was necessary at the design-freezing stage before the development of compact nuclear warheads.

The situation can now be reversed, if we forge ahead, for several reasons:

1. The agricultural crisis in Russia has diverted funds from the lunar project.
2. Multiple rendezvous, a necessary technique for lunar landing with Russia's present booster size, has proved more difficult than anticipated.
3. The U.S. is developing a broader base from which to choose alternate methods for manned exploration of the Moon, should the first method prove untenable.
4. Instrumentation and computer science is further advanced in the U.S.

At the conclusion of a successful *Apollo* project, ahead of the Russians, this country would have a highly coordinated industrial and technological capacity that alone can insure the continued freedom and growth of the U.S. in the face of political competition with communist countries and economic competition from a United Europe.

The side benefits of this industrial and technological achievement would be great. Scientists would be able to add immeasurably to man's knowledge of the origin of life, of the nature of man and the Universe. The nation would have an opportunity to afford general disarmament without risking economic depression. And a new freedom—freedom from Earth—would become man's heritage.

Richard D. Mathews
Palo Alto, Calif.

The Space Message

To the Editor:

I am writing in advance of your editorial comment on the matter of Mr. Khrushchev's apparent withdrawal from the space race—as his statement has been called. This is because of the indecent haste with which the opponents of the *Apollo* project have taken up the cry to cut funds.

Sir, *we* know the reasons for the trip to the Moon. *We* are aware of the limitless potential of space. *We* know the great effect that space can have upon the United States. It is good to remind ourselves of these facts, but we should not stop there.

Some time previously, I wrote a letter on selling space, which appeared in M/R. As you may recall, it contained a plan to bring an awareness of space to the public. It received little, if any, reaction.

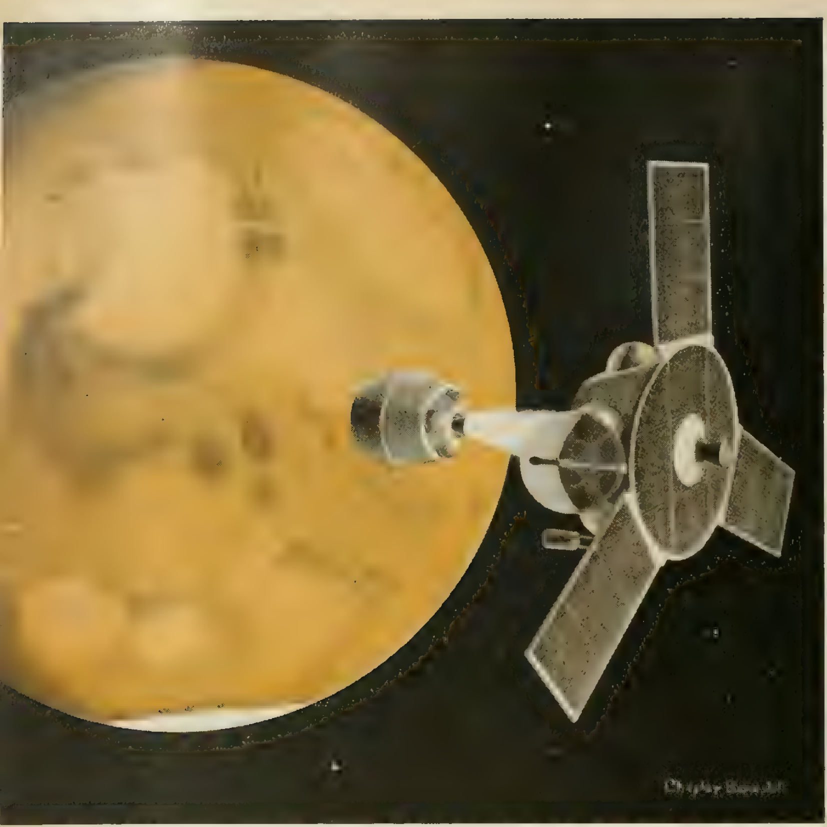
Now, let us face facts. Whether Chairman Khrushchev means it or not, his statement has given added ammunition to those who, in their shortsightedness, would wish to emasculate our space program. And, sir, these people are not only vociferous, but they have a large audience.

This is no time for complacency. It is not enough to view these manifestations with alarm, or to complain bitterly about irresponsible or thoughtless statements against space. If we wish to continue in our trip towards the stars, we must act. And when I say "*we* must act," I do not mean merely "we corporations," I mean *we:* I, and you, and everyone with an interest in the conquest of space.

Certainly, I would still advocate an approach by organized industries, as outlined in my previous letter; but this is not enough. Let us all become enthusiastic about space when we talk to our friends who are not connected with the industries. Let us paint them pictures of what space means, with all its fallout and increased standard of living. Let us show them that we are not just doing another job, but are participating in the greatest adventure that humanity has undertaken.

Let us, then, aim beyond the relatively narrow confines of the aerospace industry. Unless we sell space to our friends and neighbors, unless we let them see the vast promise of space, America's fastest-growing industry may well become America's fastest-dying one.

Stephen A. Kallis, Jr.
Chrysler Space Division
Huntsville, Ala.



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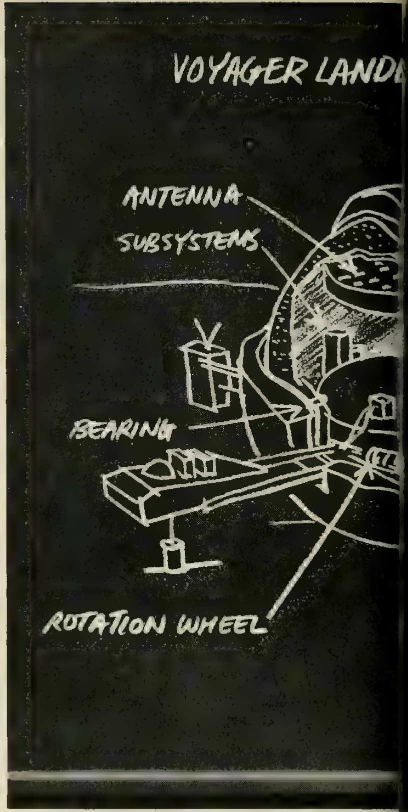


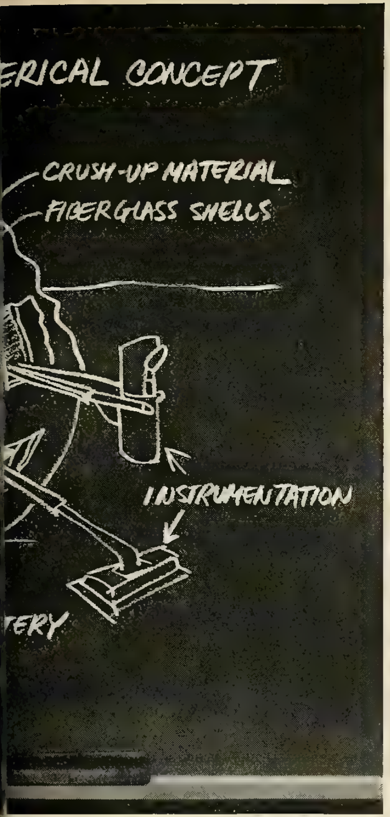
VOYAGER: The Mission.

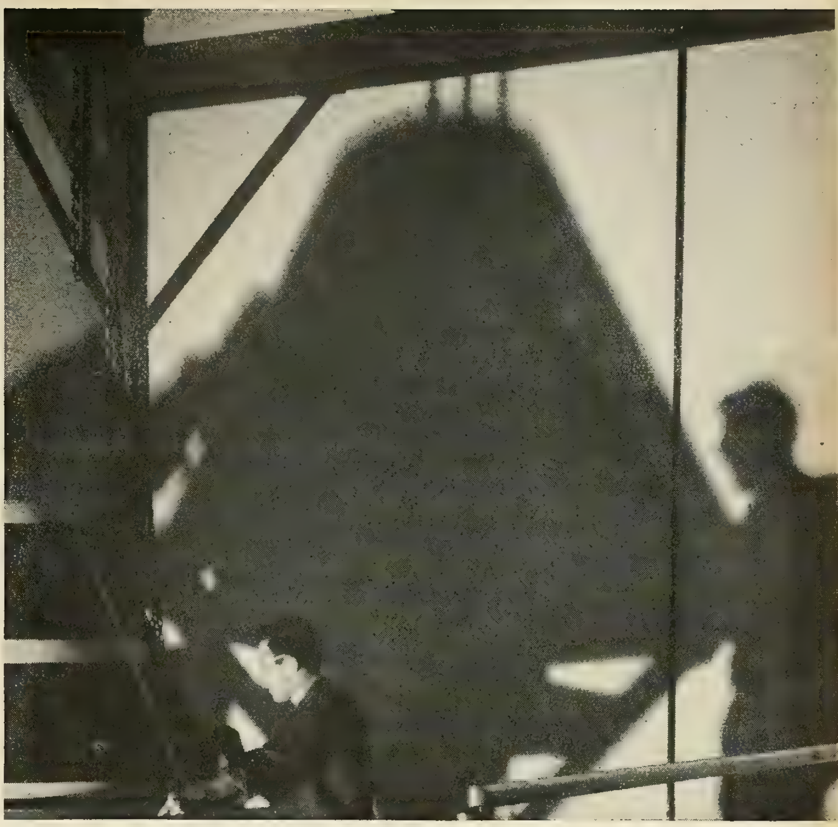
Interesting world, our neighbor Mars. It's only half the size of our own Earth. Gets around the sun in twice the time we do. Has a thin atmosphere, some moisture, reddish surface, no mountains to speak of. And perhaps some form of plant life. We'd like to know more about Mars. And Venus, too. The highly successful Mariner program has been designed to answer some of our questions. NASA's Voyager is proposed as the next step in the systematic exploration of the planets . . . targeted for the late 1960's.

Still in the study phase, the first Voyager vehicle to probe Mars (and perhaps Venus) would probably be launched by an adaptation of the Advanced Saturn booster currently programmed for Apollo. Designed to land a payload of complex instruments, it would gather a rich harvest of data that can make future manned flights possible by bringing back the answer to the basic question: "Can man land and survive on Mars?"

The Study.

Before the flight, the digging for data. NASA has asked Avco to do a six-month study program to investigate problems inherent in the development of the Voyager project. The answers will point the way for successful fabrication, launching, orbiting, and landing of Voyager vehicles on Mars and Venus.





hat is the maximum scientific
yload available in such a system?
hat kind of heat shielding will be
eded for entering these unknown
nospheres at hypervelocities?
hat kind of guidance and control
stems for putting Voyager in orbit
ound another planet? Will data
telemetered back to Earth
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The Countdown

WASHINGTON

NASA Ready to Concede Space Station to AF

Top NASA officials, faced with growing concern over the *Apollo* budget, now are ready to concede management of the manned space station program to the Air Force "if they can justify it." Already, one major contractor is weighting its design approach accordingly. The company's top R&D man says: "NASA soon will have its hands full of problems with *Apollo* hardware. The problems, inevitable in any engineering program, already are beginning to pop up and they will peak during the flight-test phase. Air Force, on the other hand, has the management, scientific and engineering capability readily for the space station."

Agencies in Nimbus Truce

Although there has been no official announcement, NASA apparently has persuaded the Weather Bureau of the impracticality of a meteorological satellite with a three-year orbit lifetime. The Bureau has dropped its support of the project and instead has asked NASA to build two to three more *Nimbus* spacecraft. It has not made a decision, however, on whether it will restore funding of an operational *Nimbus* program which it pulled out a couple of months ago (see story on p. 127).

Webb Scotches Resignation Talk

NASA Administrator James E. Webb says there is nothing to reports that he plans to resign Jan. 1. He avows that when he does leave NASA, he plans to retire and will accept no other position. Until that time, he told MISSILES AND ROCKETS, he will stay on as long as President Kennedy wants him.

AF Gemini Money Is Long Shot

Informed sources report that the odds are five to one against any DOD approval of Fiscal '65 funds for the Air Force to buy its own *Gemini* spacecraft. Best bet, if ever, is Fiscal '66 after NASA has flown some of the *Gemini* missions and its performance can be evaluated.

Lunar Orbiter To be Spin-Stabilized

Lunar Orbiter, to be launched by an *Atlas-Agena*, will be spin-stabilized rather than attitude-controlled and will take a spaced pattern of surface pictures rather than a continuous strip chart. It will store photos for transmission to Earth at the optimum point in its flight and will have somewhat better resolution than was planned for *Surveyor Orbiter*—perhaps down to one meter.

Pershing Pacific Plans Confirmed

Martin *Pershing* missiles will be deployed in the Pacific theater in about a year, Army spokesmen officially acknowledged last week. The confirmation followed an earlier announcement that *Pershing* would begin phasing out the *Redstone* in Europe early next year. West Germany will buy two *Pershing* battalions and probably two more. Surplus *Redstones* are regarded as possible hardware for use in R&D component testing, but Army spokesmen could not confirm any interservice negotiations.

Centaur Tests To Carry Surveyor Models

Several *Centaur* flight-test vehicles will carry models dynamically similar to *Surveyor* spacecraft for the purpose of collecting information about vibration and other operational interactions between the spacecraft and its launch system. The mockups also will be used in static tests at the General Dynamics/Astronautics plant and the Plum Brook, Ohio, facility. Flight test mock-ups actually will be launched into lunar-transfer orbits carrying tracking transponders so that guidance accuracy can be evaluated. *Surveyor* has the highest priority of any project assigned to *Centaur*.

NASA Eyes Dyna-Soar Alternative

NASA probably will build its own maneuverable reentry spacecraft if the *Dyna-Soar* project is not completed. For reasons of economy, it probably will be unmanned. NASA will continue to support *Dyna-Soar* with small funding in FY '65. Although preliminary drafts of the DOD budget contain money to continue it as a spacecraft research program, sources report that the project is still being reviewed by top Defense officials.

INDUSTRY

Lockheed Space Trainer Sets Unofficial Mark

Preliminary testing of Lockheed-California's rocket-boosted NF-104A aerospace trainer at Air Force Flight Test Center, Edwards AFB, Calif., produced an unofficial world altitude record from ground takeoff of 22.5 mi. The modified aircraft is expected to add another 10,000 ft. to this to enable atmospheric re-entry training at the Aerospace Research Pilot School.

Computer Displays Hit Snags

Computer-driven displays are being removed from a number of military command and control centers. Reason: lack of reliability. The displays still are considered to have a rich potential. But many specialists now feel they were placed on an operational footing too soon.

New DSIF Antenna To be Ready in 1965

First of the new 210-ft.-dia. parabolic antennas for the JPL-operated Deep Space Instrumentation Facility is now scheduled to go into operation at Goldstone, Calif., in the spring of 1965—too late for the launch of the *Mariner C* Mars probe. The big dish will be available, however, by the time the probe is at mid-course, and it may be used to transmit final commands to the spacecraft. The equipment will increase DSIF tracking and telemetry capability by a factor of seven.

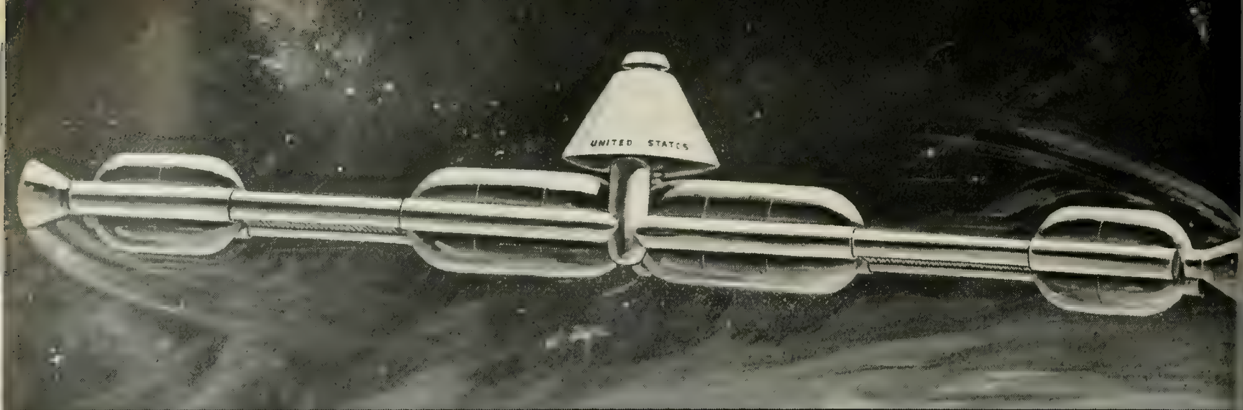
NASA Seeks Hypersonic Research Craft

NASA's Flight Research Center is seeking funds for a hypersonic research aircraft. Estimated cost: $500 million. Configuration, seen as a predecessor to *Aerospace Plane*, calls for a delta-wing vehicle capable of speeds of Mach 8-9 with a 60,000-lb.-thrust ramjet engine (see p. 211).

INTERNATIONAL

ESRO Talks Turkey in Washington

Top officials of the European Space Research Organization (ESRO) will be in Washington next week for meetings with NASA scientists. The Europeans are expected to detail their upcoming space projects as well as discuss possible areas of space cooperation with the space agency.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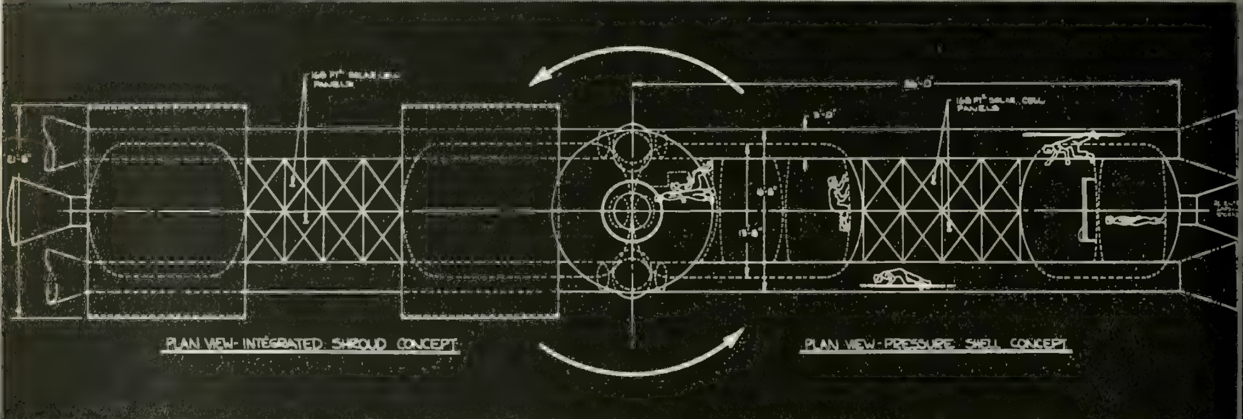
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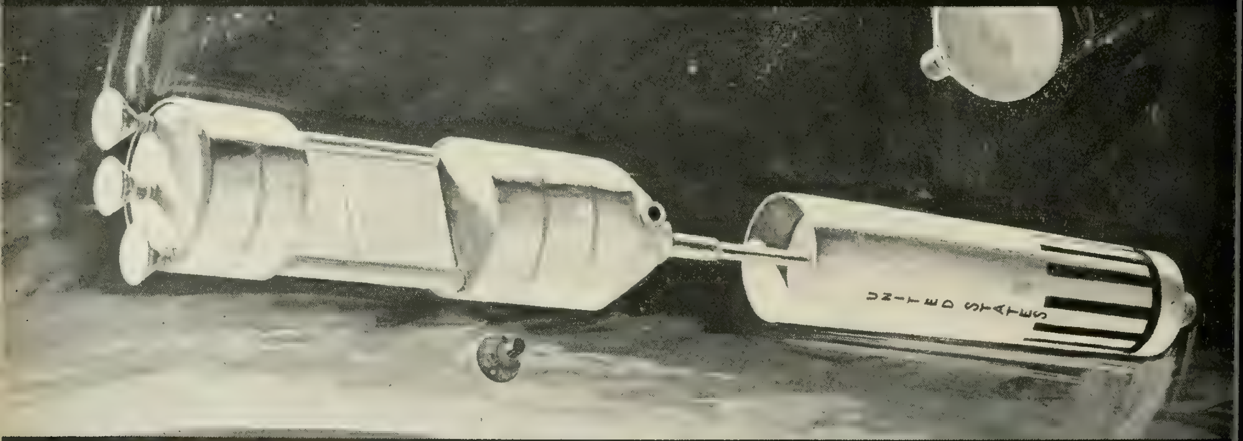
UNITED STATES

What form will the nation's first earth orbiting space station take?

Experienced Grumman design and development engineers continue to investigate all types of space station concepts —from Zero G nonrotating to rotating types. All this design effort results from the basic study of the many uses that space stations might have. As an example, earth orbiting space stations might conceivably be a twin-bladed configuration as shown above, or a multiple canister type, shown below. ■ Whatever the final design may be, the mechanical and human problems involved are enormous, demanding unique capabilities for integrating the most complex components. At Grumman, this capacity for integration is in the hands of an experienced hard core of engineers who, with free exchange of ideas in design and development, provide total systems in space technology.

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Where Advanced Ideas Grow into Reality

The Missile/Space Week

Only $5.1 Billion for NASA

The Senate unexpectedly voted to slash the NASA FY 1964 appropriation another $90 million last week, thus bringing it to the House level of $5.1 billion.

The amendment proposed by Sen. William E. Proxmire (D-Wis.) was passed by only one vote, 40-39; then NASA's budgetary fate was effectively sealed when a second motion—in effect declaring that the matter should not be reconsidered—passed 41-38. Sen. Warren Magnuson (D-Wash.) pointed out earlier that this ruled out any bargaining or discussion with House conferees, since the money figures in the NASA portion of two bills is now the same. However, conference will be held on certain word differences in the bills.

An earlier amendment offered by Sen. William Fulbright (D-Ark.) which would have cut the budget by 10% or $519 million, was defeated 46-36. After several hours of discussion on the Fulbright amendment, the Proxmire measure was called to a vote in 10 minutes and sealed minutes after.

The actions indicated that things may get tough for NASA in the next few years, especially with a year of no manned launches and elections in 1964. The trend began earlier this year with the authorization. The Senate Space Committee had restored more than $300 million in House authorization bill cuts, but this amount nearly was chopped off again by a Senate amendment from the floor—defeated only 35-32.

- **Military space**—Quite a bit of the discussion on the floor concerning the advisability of cutting the NASA budget centered on the question of whether NASA's research was applicable to military space programs and whether it contributed to the national security.

Sen. Stuart Symington (D-Mo.) said that he would "much prefer to see the country save money . . . by taking some of the divisions out of Europe" than by compromising in an area where someday the U.S. might be called upon to defend itself.

Fulbright contended that it would be unlawful to base NASA's budget on national security, since this would contradict the Space Act of 1958, which specifically states that NASA be confined to peaceful interests.

Sen. George A. Smathers (D-Fla.), in opposition to cutting the bill, cited a number of medical devices and other commercial fallout from the space program. Fulbright argued against this point by saying that "medical research belongs in medical programs" and that such justification was far-fetched.

Fulbright described the space bill as a "great big grab-bag of goodies for everybody," and predicted that his amendment would not carry because the NASA programs reach into the home states of too many Senators. However, a number of Senators reversed their votes for the second amendment.

In the discussion time before voting, senators (most of them for the cut) cited unemployment relief and education as fields which should receive the money in the NASA bill. Sen. Fulbright said he advocated a re-allocation of funds to these areas in his amendment.

The NASA budget is part of a $13.4-billion Independent Offices Appropriation, which the Senate passed and sent to conference last week.

Air Force to Manage PMR

The Department of Defense last week confirmed that the Air Force will assume management of the Pacific Missile Range from the Navy.

Plans for the move were originally reported exclusively in Missiles and Rockets Aug. 12, p. 12.

A central authority to be set up within the Air Force (probably within AF Systems Command) will coordinate planning of Atlantic Missile Range activities, as well as ICBM and space activities in the Pacific and the AF Satellite Test Center, Sunnyvale, Calif.

The Navy will retain management of the Pt. Mugu, Calif., sea test range.

Defense Secretary McNamara has further ordered that:

—The Point Arguello, Calif., launch area will be transferred to the AF in several stages, and its management will be combined with that of nearby Vandenberg AFB. AF will take custody of land and housekeeping functions in Fiscal 1965. In-

Titan II Stage Separation Photographed

MARTIN COMPANY camera mounted aboard the firm's Titan II second stage records sequence of Gemini booster's first stage separating and falling away in recent booster test shot from Cape Canaveral. First unmanned Gemini shot is scheduled early next year.

U.S. NAVY
canoga

Mobile Radar Tracker—The AN/MPS-26, Canoga's versatile C-band radar tracker, soon to be housed in a roomier instrumentation van. An example of the continuing product improvement practiced at Canoga is the new electronic switching technique now incorporated in the long range tracker in place of the customary mechanical devices.

One-Man Operation—This is the inside view of the one-man MPS-26 radar. Mor space for instrumentation and data handling equipment will be provided in a ne larger van, now being manufactured. The larger MPS-26 van will also add ben fits of better maintenance and lower MTTF (mean time to fix), with its mor readily accessible circuitry.

advanced tracking

from canoga

National Aeronautics and Space Admin istration Goddard Space Flight Cente chose Canoga for a key position on th tracking team whose job it is to modif

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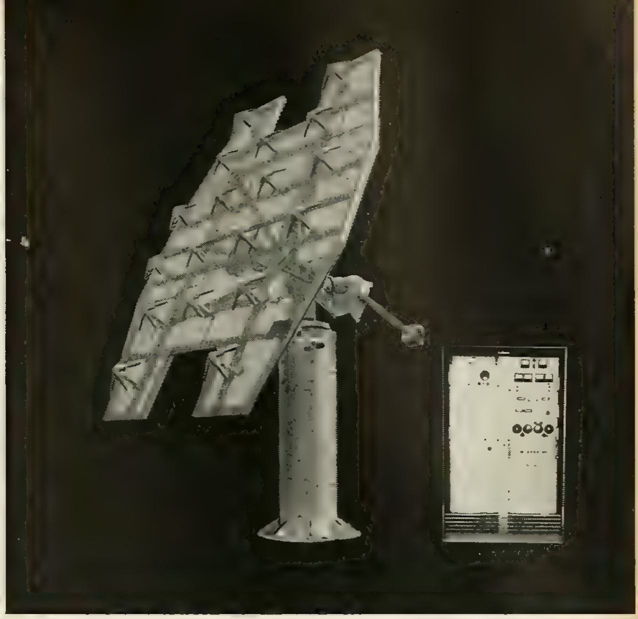
tal Capability—This is a typical Canoga data processing system, representing
oga's telemetry-radar-digital tie-in capability. It samples the digital encoders
umerous optical, radar and telemetry tracking mounts, formats and time tags
data for the processing computers.



Fan-Beam Telemetry Tracker—Teltrac II, Canoga's latest addition to its line of telemetry trackers. The antenna is new with its 18-element crossed-dipole, fan beam array, minimizing the problems of multipath at lower elevation angles. The crossed-dipoles can be easily switched to accept energy of any polarization. The new tracking receiver tracks all IRIG telemetry carriers, even when the basic carriers apparently disappear in the modulation. Handy front panel controls allow the operator to quickly adjust to any signal configuration.

echnology

or NASA

nd expand the present Mercury net-
ork to meet the much more demanding
strumentation and tracking require-
ents for Gemini and Apollo.

cle No. 2 on the Reader Service Card for more information.

strumentation and range safety operations are to be in AF hands by FY '66, as are the Pacific impact areas, after detailed implementation studies are completed.

—AF will be given clear responsibility within DOD for in-orbit satellite control, with the exception of the Navy's *Transit* navigational satellite and military communications satellites, over which the Army has had control since the military comsat program began.

—Instrumentation ship conversion will be assigned to the Navy technical bureaus, and the Military Sea Transportation Service (MSTS). MSTS now operates these vessels used at PMR, but AF has done so under contract at AMR. DOD says that in the future, operation of any AMR ships on contract will be under MSTS auspices.

—By Fiscal '66, antimissile test support facilities at Kwajalein Atoll in the Pacific will be transferred to the Army, and space tracking facilities in the Pacific (now divided between AF and Navy) will go to the Air Force. Details of these transfers are to be determined by studies now getting under way.

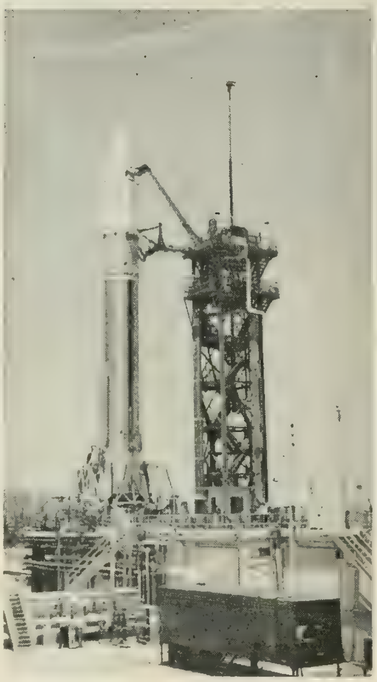
Titles for the new organizations that will evolve from these changes have not been selected. Albert C. Hall, Deputy Director of Defense Research and Engineering (Space), said that the central authority within the AF that will serve as coordinator of these activities under the new policy will probably be a part of AF's Systems Command, but the decision has not yet been made. Nor has a commander been chosen.

(MISSILES AND ROCKETS earlier reported that the transfer of PMR to the Air Force would result in creation of a new division within Systems Command, consisting of AMR, PMR and the Satellite Test Center at Sunnyvale. Sources also indicated to M/R that Maj. Gen. Leighton I. Davis, presently commanding the Atlantic Missile Range, would assume command of the larger division.)

Hall doubted that procurement at AMR and PMR would be fully unified, but said that one goal of the changes is to gain as much uniformity as possible in ground-support equipment and other materials purchased for the two ranges.

The move will probably mean the Air Force will assume funding of those activities it acquires from the Navy.

Shifts in personnel strength at Patrick AFB, Fla., now headquarters for AMR, would be phased over about a year as responsibilities are shifted to the Air Force.



ATLAS-CENTAUR being prepared for launch, scheduled for Nov. 26 from Cape Canaveral.

Centaur Set to Go

The U.S. space program will reach a critical moment this week with the attempt to launch the *Centaur* liquid hydrogen upper stage.

The launch, using an *Atlas* booster, will be attempted no earlier than Nov. 26. If successful, NASA can expect, at least for the present time, to hold to its schedule for unmanned *Surveyor* spacecraft.

If unsuccessful, slippage of 4 to 6 months can be expected in the program, which is so important to Project *Apollo*.

In this second developmental flight, *Centaur* will not carry a scientific payload. The burned-out *Centaur* second stage—weighing about five tons—will go into orbit, however, and the weight of a spacecraft will be simulated by developmental instruments located throughout the vehicle to gather flight performance data.

After burnout and separation of the *Atlas* booster and sustainer engines, the two second-stage engines will be ignited and burn for more than 6 minutes (380 seconds). If it performs as planned, the empty *Centaur* stage—weighing about 10,200 lbs.—will be injected into Earth orbit with an apogee of 1,035 statute miles and a perigee of 345 mi. This will result in an orbit of the Earth in a little under two hours. The launch azimuth will be 100.5 degrees.

First, however, the vehicle must be proven in flight test. This is the second of eight planned *Centaur* vehicle test flights.

Launch of *Centaur* on May 8, 1962, ended 55 seconds after lift-off when a weather shield came off the second stage and was followed by a rupture of the hydrogen tank, which resulted in an explosion.

That unsuccessful flight was followed by a critical re-appraisal of the *Centaur* development program. Both government and industry *Centaur* program management was tightened, and responsibilities were more specifically defined.

Major test objectives of the *Atlas/Centaur-2* mission are to:

—Demonstrate the structural integrity of the *Atlas/Centaur* vehicle.

—Verify the *Atlas/Centaur* separation system.

—Demonstrate the ability of the *Centaur* propulsion system to be ignited in space and to burn for 380 seconds.

—Evaluate the accuracy of the *Centaur* guidance system.

In appearance, the vehicle closely resembles the *Centaur* test mission A number of significant changes hav been made, however, both in th space vehicle itself and in flight procedures.

One important change is in th engine chilldown procedure, whic results in an increase of some 5 pounds of payload. Improved RL-1 engines will be used on *AC-2*. Second-stage insulation panels and the payload nose fairing, normally jettisone after the vehicle leaves the atmosphere, will remain on throughout th *AC-2* mission since no payload i being carried.

H-1 Contract Definitized

NASA has signed a definitize contract with Rocketdyne Div. o North American Aviation, Inc., fo 114 H-1 rocket engines and associated equipment.

Total cost is $19,733,805, wit $6,525,230 already paid to the company.

In addition to the H-1 engines Rocketdyne will provide 20 engin adapters, 40 engine transporter adapter assemblies, various suppor services and other supplies. Most o the work will be done at the firm' Neosho, Mo., plant with some to b done at Canoga Park. The contrac expires Jan. 31, 1966.

The H-1 engine burns liquid oxygen and kerosene in producing 188,000 pounds' thrust. Eight of th

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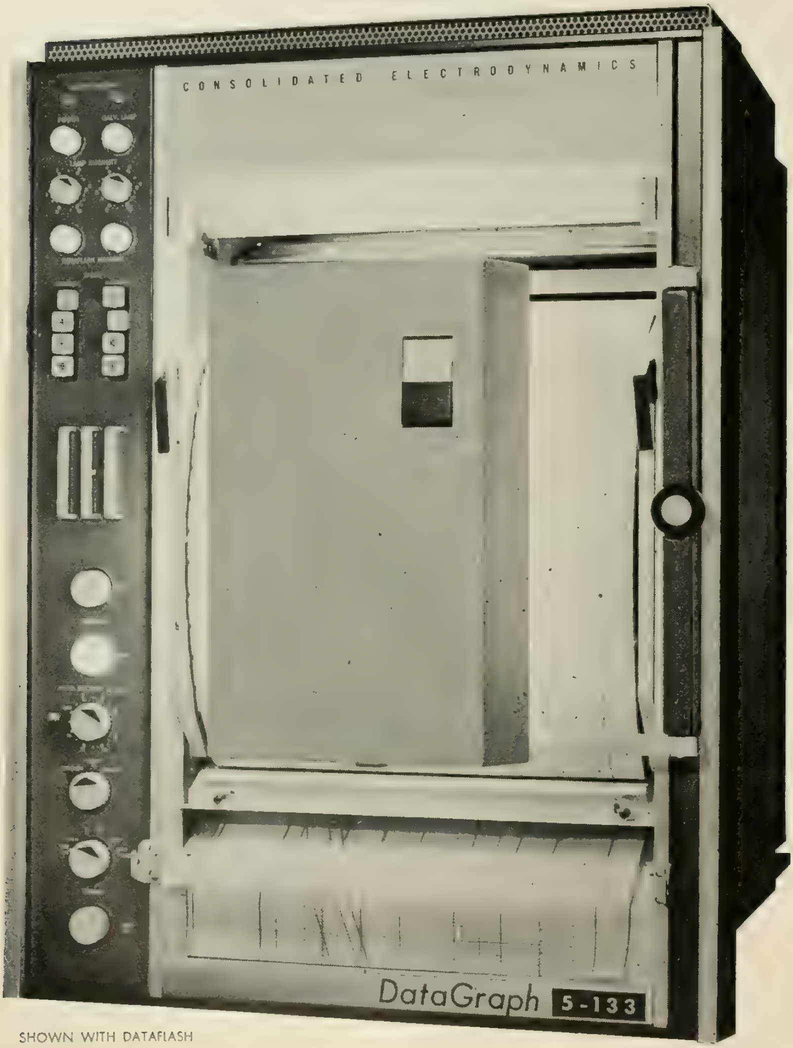

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TWELVE RECORDING SPEEDS – *pushbutton selectable speeds of .1, .4, .8, 1, 1.6, 4, 8, 10, 16, 40, 80, and 160 inches-per-second.*

TRACE IDENTIFICATION – *trace interruption and trace numbering.*

VIBRATION ISOLATION – *four isolator mounts on recorder and four on the drive motor/transmission assembly.*

GALVO LIGHT INTENSITY CONTROLS – *manual and automatic controls provide optimum trace quality for each block.*

FILTERED AIR COOLING – *cools and pressurizes the optical module for maximum cleanliness.*

MODULE CONSTRUCTION – *all modules removable as single assemblies.*

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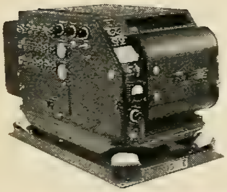
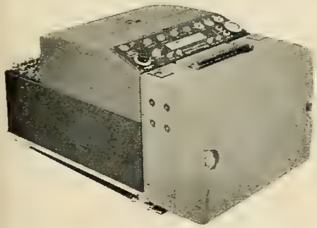
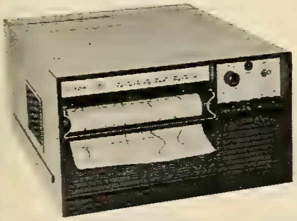


CEC's 5-114 DATAGRAPH Recording Oscillograph is available in 18 or 26 trace models; produces 225-ft. records on 7-inch-wide paper. The instrument's DATARITE accessory provides immediate access to records.



CEC's 5-119V DATAGRAPH Recording Oscillograph, the "universal" oscillograph, makes conventional, DATARITE® (Flash Developing Process), or print-out records; 36 or 52 channels, a-c or d-c models with 12" wide oscillograms. Speed: 0.1 to 160 ips.



CEC's 5-124 DATAGRAPH Recording Oscillograph is portable, direct-writing, weighs only 40 pounds. It is low cost and loads easily. Up to 18 traces may be recorded on 7"-wide-paper. Further data? Call or write for Bulletins in CEC Kit #3472-X10.

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engines are clustered to give the *Saturn I* and *IB* space rockets 1.5 million pounds' thrust.

The engines are scheduled for use on *Saturn IB* boosters being built by the Chrysler Corp. at Marshall Space Flight Center's Michoud Operations plant in New Orleans.

Ohio Seeking ERC

The list of cities vying with Boston for NASA's proposed $50-million space electronics research center is growing, with Cleveland among the latest in contention.

A Cleveland delegation last week extolled the merits of the city's location to space agency officials. Cleveland is already the home of NASA's Lewis Research Center, and also of Case Institute of Technology and Western Reserve University.

Ohio's Democratic senators, Stephen M. Young and Frank J. Lausche, feel the center would be a good thing anywhere in the state, and representatives of three other Ohio cities—Columbus, Sandusky and Chillicothe—have argued their cases for location of the center before NASA officials.

Shots of the Week

The Navy demonstrated its *Polaris A2* for President Kennedy Nov. 16 during his visit to Cape Canaveral (see p. 30). While the President watched from the USS Observation Island, the crew of the submarine Andrew Jackson successfully launched the missile toward a target 1,300 mi. down the Atlantic Missile Range.

Other shots of the week:

- NASA fired an *Aerobee* sounding rocket to an altitude of 115 mi. Nov. 16 from Wallops Island, Va. The rocket carried 200 lbs. of instruments designed to measure ultraviolet radiation.
- A Strategic Air Command crew successfully launched an Air Force *Titan I* ICBM from Vandenberg AFB, Calif., Nov. 14.
- NASA's *X-15* was flown Nov. 14 from Edwards AFB, Calif. Air Force Capt. Joe Engle put the rocket plane through a series of maneuvers to simulate what the *X-15* and its pilot might encounter if control failure occurred in the craft.
- The Army fired a *Pershing* tactical missile 230 mi. overland from Ft. Wingate, N.M., into the White Sands Missile Range Nov. 14
- Also on the 14th, the Air Force successfully launched an *Atlas D* ICBM from Vandenberg AFB, Calif, toward a target 5,000 miles down the Pacific Missile Range.

LALO Award in Offing

San Diego, Calif.—The Army is believed to be close to issuing a study contract to General Dynamics/Convair after viewing an unmanned battlefield Low-Altitude Observation (*LALO*) system the division is flight-testing.

LALO, under development for several years, would operate at altitudes of up to two miles. It's reported that it would present a much more difficult target than a manned aircraft. It would carry real-time sensors such as television and radar, but could also be used with photographic cameras. It utilizes narrow-beam communication for a high degree of security with low power, and has a directional data-link to provide target location as well as identification.

Designed primarily for surveillance, the system could double as a carrier for delivery of critical items or weapons and as a communication repeater.

The concept may vitally affect future Army procurements, perhaps those of other services. For example:

—*LALO* units might assume a significant portion of the role now filled by manned reconnaissance aircraft. The system is considerably cheaper than manned aircraft.

—While originally envisioned as an observation system, it is conceivable such a vehicle could be developed as an aerial weapons system for support of ground troops.

—Aircraft could launch and control such systems to perform long-range observation and/or weapons delivery missions in comparative safety.

Senator Urges Space Foresight

The United States should begin thinking right now about what its next major objective in space after *Apollo* should be, a leading member of Congress has said.

Sen. Clinton P. Anderson (D-N.M.), chairman of the Senate Astronautics and Space Sciences Committee, told the 1963 Annual Conference of the Atomic Industrial Forum, Inc., that future goals in space should be getting serious consideration now, "in an atmosphere somewhat removed from pressures of the moment."

Anderson listed such possibilities as flybys and instrument landings on Mars to search out extraterrestrial life, an orbiting space platform for scientific and military research, and establishment of exploratory bases on the moon. Long term planning, he noted, is "essential to the effective spending of vast sums of money, the marshalling of thousands of scientific and technical skills and the construction of large installations. . . ."

The New Mexico Senator announced that the Senate Space Committee was beginning hearings on the impact of the national space program on education and the nation's academic institutions. He said the committee was particularly interested in how NASA's program of graduate fellowships and research facility grants is working in relation to the total Federal activity in aid to higher education.

The Senator also suggested that an annual report should be given to the Congress on the "state of science and technology," briefly discussing the major programs in science and technology and setting forth what problems that would require Congressional attention. A report on the "state of engineering" might also be helpful, he said.

AEC Cuts to Hit SNAP, Rover

The *SNAP* and *Rover* programs stand to suffer from a House of Representatives cut of $115 million from the AEC appropriations bill. A total of $2.3 billion remains.

One of the biggest AEC program cuts—$33 million—was made in the category of reactor development, which includes the *SNAP* and *Rover* programs. The House Public Works Appropriations subcommittee said the reduction was based on 6-month availability of the 1964 appropriation. The amount is roughly half the increase over the 1963 program. The House voted to allow a total of $497 million for this category.

Nuclear Propulsion Championed

New York—Members attending the winter meeting of the American Nuclear Society and Atomic Industry Forum last week heard top industry and government spokesmen come to the technical and economic defense of nuclear space propulsion and on-board power systems while cautioning against DOD policies that threaten "the real payoff" in application in this field.

Keynote was struck in remarks prepared for delivery here by Rep. Melvin Price (D-Ill.), chairman of the subcommittee on research, development and radiation of the Joint Committee on Atomic Energy.

Price, taking a slap at DOD cost-effectiveness evaluations, which have put the damper on a second nuclear aircraft carrier, said that "Too often

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Reliability Engineers—BS in EE, ME, AE and experience on aerospace systems, to engage in system and sub-system reliability control activities including one or more of the following: apportionment, prediction, configuration (trade-off) studies, failure mode and failure effect analyses, electronic circuit analyses, maintainability analyses, environmental analyses, implementation of reliability programs, design reviews, trouble data collection and analyses and vendor control. Special experience areas include: Propulsion, Environmental Control, Stabilization, Guidance & Control.

Component Parts Engineers—BSEE preferred plus experience in electronic component part evaluation and applications of semiconductor devices and other electronic components. Responsibilities will include part selection, determination of part reliability requirements, establishing deratings and establishing test and procurement specifications.

Space Systems Engineers—BS or advanced degree with experience in the analysis of integration of overall systems for orbital and lunar exploration, reconnaissance or surveillance and space weapons applications. Applicants should possess working knowledge of the various components or subsystems of space systems such a communication, stabilization, guidance, digital and analog control, and environmental control systems and have a good background in space mechanics. Positions encompass conceptual work in defining systems to match requirements, analysis and synthesis of these systems, simulation, and final verification.

Programmer—One to three years of experience in scientific programming on general purpose equipment including at least one year on the IBM 7090-7094 type equipment. Knowledge of FORTRAN with a desirability for familiarity with FAP. BS degree in Science, Mathematics, or Physics as a minimum desirability for engineering orientation.

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From Moon Bounce to ASW

SOME TECHNICAL HIGHLIGHTS OF A DIVERSIFIED YEAR OF RESEARCH

As an independent, non-profit research organization, Cornell Aeronautical Laboratory has, in the past fiscal year, completed or appreciably advanced the maturity of over 300 different projects in widely varying areas of technology. These efforts included some $18 million in contracted research.

As reported in the recent "1963 Report on Research," here are but a few of our programs:

- Moon-bounce radar echoes using the laboratory's High Power (50 megawatt peak) radar were examined for clues to the constitutents and shape of the lunar surface. The High-Power system also was employed to yield significant new information in studies of radar backscatter from the ionosphere.
- An investigation in stellar guidance systems was undertaken to determine the predictability of stellar-ray distortions associated with the hypersonic flow-field environment and included experiments in the 48" hypersonic shock tunnel.
- In terrain-following research, an intensive flight program was successfully completed with a series of fully-automatic, low-altitude flights utilizing the CAL developed AUTOFLITE system in a jet aircraft.
- Progress was made in antenna designs for aerospace vehicles during reentry to assure antenna survival, satisfactory coupling to the plasma medium and minimum distortion of the antenna pattern. In a similar area, short duration hypersonic testing techniques were applied to microwave-rocket plume investigations.
- In hypersonics, our research included: investigation of non-equilibrium ionization in nozzle flows using interferometers to study electron recombination rates; experimental studies of variations in missile base-heating for Saturn and Centaur stages; initial fabrication of a new shock tube designed to produce 40,000 ft/sec at altitudes of 250,000 feet; and first operational testing in the Wave Superheater — the long duration hypersonic tunnel with capabilities up to Mach 15 and 8500°R for periods up to 15 seconds.
- In AICBM technology, radar discrimination techniques were studied for identifying enemy warheads in the presence of penetration aids with significant contributions made in signature determination and automatic data processing. Analytical studies of terminal defense were performed, supported by computer simulation emphasizing interceptor trajectories, component requirements, and warhead design.
- For the Supersonic Transport, our efforts included a technical and economic evaluation of the feasibility of a commercial SST, the use of our variable-stability B-26 to study the handling qualities of a supersonic transport on final landing approach, and the design and evaluation of two adaptive control systems applicable to such an aircraft.
- The laboratory's ability to perform "cold" radar cross-section investigations at model scale confirming full scale measurements was furthered by a new precision FM/CW range, capable of 3-inch range resolution with a compression ratio of about 10,000 to 1.
- In the field of cognitive systems, an elementary automatic photo interpretation system was demonstrated using general-purpose digital computer programs and a special purpose input-output facility.
- Anti-submarine warfare studies included such programs as investigations of a data processing system for manned aircraft engaged in ASW operations, comparative system evaluation of various submarine propulsion and control systems, and basic research on adaptive signal detection systems.

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we stop short of the real payoff in our R&D projects because the cost-effectiveness boys apply the emergency brake. Sometimes I think that they believe success will spoil Uncle Sam."

Price said that "DOD, largely because of these so-called cost-effectiveness studies, is not willing to pay the price for a better product."

AEC's Dr. Frank Pittman, SNPO's Milton Klein and other scientists, at separate sessions, came to the defense of the *Rover* project, which has undergone considerable questioning since the last unsuccessful "hot" firing of the Kiwi reactor.

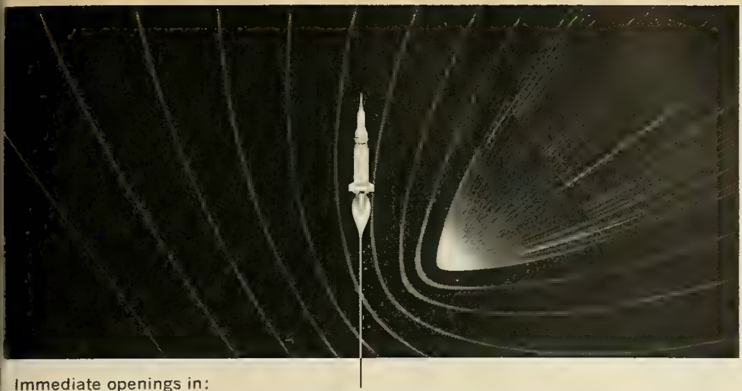
Klein said that design changes, as the result of recent cold-flow tests, have enhanced the reactor core stability to keep damaging vibration levels minimized, and that the next hot firing of the Kiwi B4D is now slated for early next year. Klein emphasized that this next shot was one of a series planned for the next 12 to 18 months, which as a series would determine "whether we are far enough out of the woods to have an operational system available for an early 1970 flight."

Klein said that specific impulses "in excess of 700 seconds" would be achieved with the flight system, and that laboratory evidence indicates that engine re-start would be possible, though it has not yet been proven. Klein said that missions planners have shown that by proper staging, some of the missions could be done without re-starting.

Using an orbital start and transfer operation for a nuclear stage in a lunar base supply mission, said Klein, would result in a 25 to 30% increase over chemical rockets in delivered payload on the lunar surface.

Similar figures were cited by NASA's Dr. Wernher von Braun at a later session. Von Braun also added that perfection of nuclear upper staging for this type mission could eventually eliminate every fourth or fifth *Saturn* launching in an LLS program.

Von Braun also asserted the economy to be gained through development of a nuclear-powered spacecraft that would be lifted into Earth orbit with conventional boosters, fueled with liquid hydrogen in orbit, deliver a payload or LEM-type module to the lunar surface in much the same rendezvous fashion as *Apollo*, then return to Earth orbit where it could detach any Earth-destined payload. In this manner, there is no Earth re-entry for the nuclear vehicle, and the same vehicle, refueled in orbit, could be used many times for the same mission.



Immediate openings in:

AEROBALLISTICS

AEROTHERMO MECHANICS—Aerodynamic testing, analysis, stability and air loads; wind tunnel model design, heat transfer studies, thermodynamics of power systems and cryogenic storage, aerothermo research in theoretical gas dynamics and computer programs.

FLIGHT MECHANICS—Trajectory analysis, optimization and staging, guidance and control, orbital and space rendezvous mechanics, evaluation of overall performance, launch and separation dynamics, celestial mechanics, elastic body feedback stability, elastic body wind response and dynamic analysis.

ELECTRICAL and ELECTRONICS

LEAD ELECTRICAL ENGINEERS—Direct design and refinement of multi-connector power and signal distribution cables and harnesses, and prepare environmental test programs. Requires knowledge of MIL-Specs.

ELECTRONIC DESIGN ENGINEERS—Power supplies, converters, inverters and space vehicle batteries.

LAUNCH OPERATIONS—RF and INSTRUMENTATION ENGINEERS

MEASURING ENGINEERS—End to end calibration and check out of airborne sensing and signal conditioning, and instrumentation ground recording devices.

TELEMETRY ENGINEERS—Alignment and readiness certification of complete airborne telemeter systems (PAM, PCM, FM/FM, Single—Side Band/FM), and ground telemeter receiving, recording, demodulating and monitoring systems.

RF ENGINEERS—Testing, adjusting and calibrating complete airborne and ground integrating, receiving and display systems such as "C" Band Beacons, Azusa, Mistram, Command, etc.

MATH ANALYSTS—ANALOG GROUP

MATH ANALYSTS—Digital or analog programming of large scale scientific computers.

ANALOG ENGINEERS for set-up of machine analysis of problems, taking into account discontinuities, time scale, scale factors, etc.

QUALITY CONTROL

Develop, analyze and evaluate quality control instructions and test procedures; recommend corrective action and design changes; final performance testing and specification preparation for testing assemblies and components of guidance and control systems, RF or TM systems, and overall space vehicle systems.

RELIABILITY

Develop analysis methods and techniques, perform analysis in electrical, mechanical, electromechanical, structural, propulsion, systems and other areas; prepare logic equations for use in the Math Model and to reflect changes in system logic; analyze and evaluate test procedures, and histories of tests, pre-flight and flight data for computation of reliability attainment factors; provide design support and recommend engineering changes.

STRUCTURAL, PROPULSION and RELATED ENGINEERING

Stress, structural dynamics, propulsion, propulsion systems design, analysis of hydraulic, pneumatic, hot gas and cryogenic component and systems; aerodynamic loads, weights, materials, documentation, drafting, installation design, and development of computer solutions for all phases of structural and mechanical analysis.

PERFORMANCE ANALYSIS and EVALUATION—Prepare mathematical equations characterizing propulsion systems, subsystems and components adaptable to digital computation; use analytical methods in predicting propulsion system performance from test data, and evaluate propulsion system flight performance from telemetered data and other records.

SYSTEMS OPERATIONS

Establish operations and maintenance plans and procedures. Coordinate and establish GSE, servicing, and facilities requirements among various design and operations groups. Prepare technical descriptions of complete launch complex and vehicle.

SPACE DIVISION **CHRYSLER CORPORATION**

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Von Braun said a system of this type could reduce the cost of putting a payload on the Moon to under $100 per pound.

Pittman, who noted that there was nothing that could be construed as a "back-up" for *Rover* on the horizon, said that "nothing has come about to indicate it is not feasible."

Pittman also revealed not-yet published conclusions of a study of *SNAP* systems that his Reactor Development Div. is making. There will be some reorientation of the *SNAP* effort, Pittman said, "but no major overhaul, and not much effect on industry." Major item appears to be a shift away from mission-oriented research and development. This would reverse the trend to develop systems to specific requirements in favor of basing requirements upon available technology.

Pittman said the study would show that nuclear systems would not be used, due to inherent radiation problems, if any other source can fill the requirement. However, while chemical and solar systems may be adequate for the lower end of power demands, long-duration operation and high power demands in excess of 10 kw would likely fall to nuclear systems, in addition to some low power systems that may have unique requirements. Pittman added megawatt range operation was feasible.

Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, also advocated a push toward less mission-oriented R&D.

Avco's Dr. Arthur R. Kantrowitz, commenting upon the possibilities for nuclear systems aboard manned space stations, felt that a Russian space station launching could easily jar the U.S. space program into a major shift in emphasis.

Kantrowitz, deploring the manner in which the Russian achievements seem to activate our program, said that "when there is a military potential in space, it must have the overriding priority. The U.S. would not tolerate the asymmetry of a Russian space station."

Heat Shield Material Tested

Lockheed Missiles & Space Co.'s Research and Development Div., Palo Alto, Calif., is develop-testing a new class of composite materials based on inorganic bonding of refractory fibers, which the firm believes will be
superior for many future heat shie
requirements.

LMSC says the technique permi
a variety of refractory fibers to l
bonded without losing their mo
desirable physical property and a
lows development of composite mat
rials with varying density and the
mal properties, tailor-made throug
filament winding to meet specif
needs.

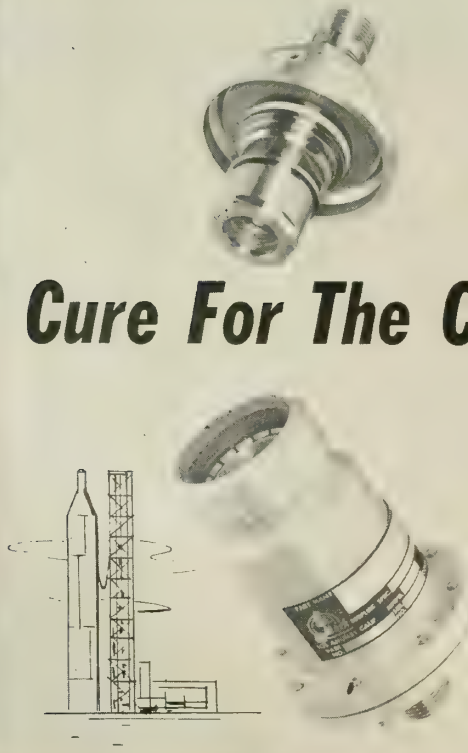
Tests indicate the materials wou
be suitable for various applicatio
in re-entry heating control, ablati
nozzles and ascent heating contr
In some applications, the materi
might be able to double as the he
shield and its structural membe
Because of unique properties in com
bination with ability to control ele
trical properties, the materials ma
have a valuable use in high-tempera
ture radomes.

Lockheed engineers appear opt
mistic about the new materials, b
the firm has not indicated when the
will be marketed. These are the di
tinctive features of the material
cited by Lockheed.

—Refractory fibers are bonded i
organically.

—Fibers can be bonded withou
losing their fiber properties.

—The techniques allow creatio



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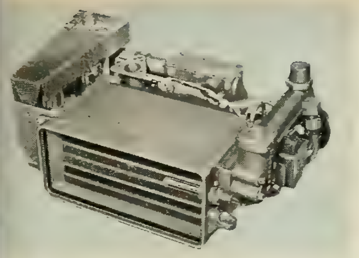
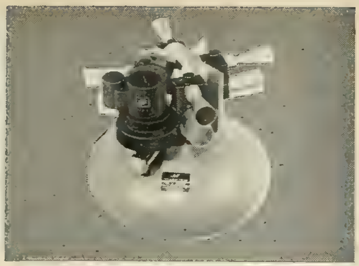
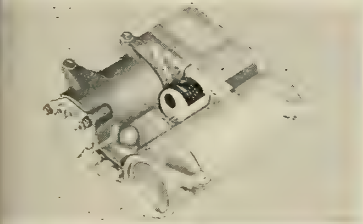
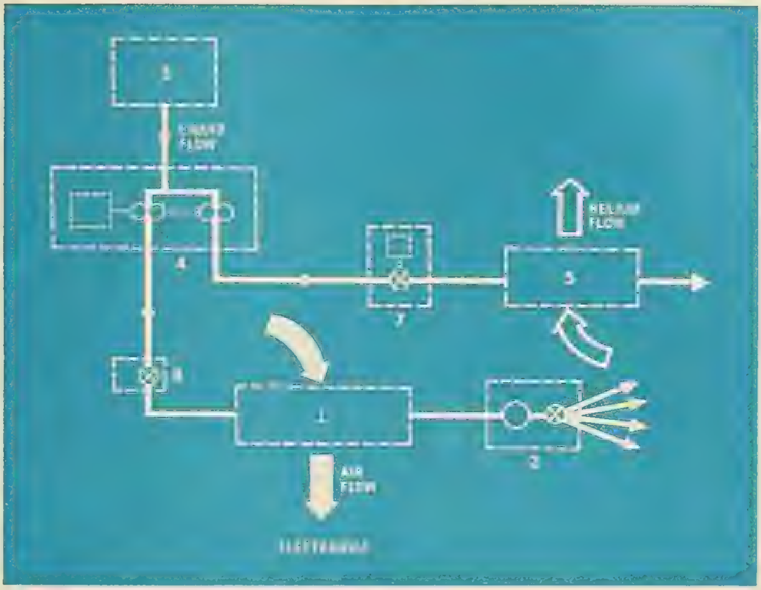
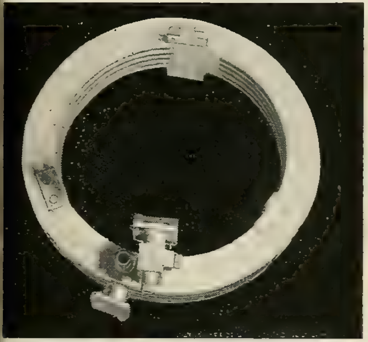

1. Electronic controlled heat exchanger

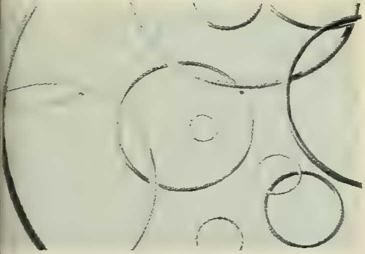

2. All attitude control system

3. Fluid tanks, reservoirs, pressure vessels

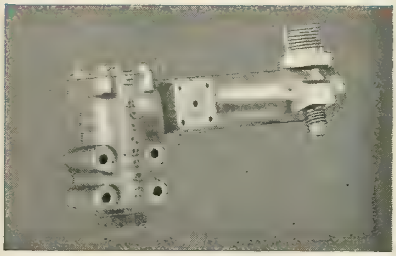

. Hydraulic power supply—pump/compressor




5. Zero-G heat exchanger


6. United Metallic O-Rings

7. Motor operated valve


8. Mass flow control valve

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99 SUCCESS STORIES

LOX AND LN_2 STORAGE (–297 TO –320° F)

NO.	COMPANY	CAPACITY*	LOCATION
1	AIR PRODUCTS	131 MG OF LN_2	CHICAGO, ILL.
2	AIR PRODUCTS	82 MG OF LOX	CHICAGO, ILL.
3	AIR PRODUCTS	78 MG OF LOX	CLEVELAND, O.
2	AIR PRODUCTS	52 MG OF LOX	PITTSBURGH, PA.
1	AIR PRODUCTS	52 MG OF LOX	WIERTON, W. VA.
1	AIR PRODUCTS	62 MG OF LOX	SPARROWS PT., MD.
2	AIR PRODUCTS	178 MG OF LN_2	SPARROWS PT., MD.
3	AIR PRODUCTS	100 MG OF LOX	SANTA SUSANA, CALIF.
1	AIR PRODUCTS	200 MG OF LOX	SANTA SUSANA, CALIF.
1	AIR REDUCTION	54 MG OF LN_2	CITY OF INDUSTRY, CALIF.
1	AIR REDUCTION	54 MG OF LN_2	S. ACTON, MASS.
1	AIR REDUCTION	270 MG OF LN_2	RICHMOND, CALIF.
1	AIR REDUCTION	108 MG OF LN_2	BEAUMONT, TEX.
1	AIR REDUCTION	43 MG OF LOX	BEAUMONT, TEX.
1	AIR REDUCTION	350 MG OF LOX	BUTLER, PA.
1	AIR REDUCTION	350 MG OF LOX	CLAYMONT, DEL.
1	AIR REDUCTION	330 MG OF LN_2	BUTLER, PA.
1	AIR REDUCTION	330 MG OF LN_2	CLAYMONT, DEL.
1	AIR REDUCTION	330 MG OF LN_2	ACTON, MASS.
1	AIR REDUCTION	50 MG OF O_2	CHICAGO, ILL.
1	AIR REDUCTION	50 MG OF O_2	CITY OF INDUSTRY, CALIF.
2	AIR REDUCTION	350 MG OF LOX	ALBION, MICH.
1	AIR REDUCTION	300 MG OF LN_2	WARREN, OHIO
1	AIR REDUCTION	300 MG OF LOX	WARREN, OHIO
1	DRAVO	110 MG OF LOX	FARRELL, PA.
1	DRAVO	35 MG OF LN_2	FARRELL, PA.
1	FORD MOTOR CO.	115 MG OF LOX	DETROIT, MICH.
2	LINDE	217 MG OF LOX	HUNTSVILLE, ALA.
1	LINDE	700 MG OF LOX	HUNTSVILLE, ALA.
1	LINDE	700 MG OF LOX	ASHTABULA, O.
1	LINDE	217 MG OF LOX	PUEBLO, COLO.
2	LINDE	217 MG OF LOX	NEOSHO, MO.
1	LINDE	217 MG OF LOX	EAST CHICAGO, IND.
1	LINDE	131 MG OF LOX	LACKAWANNA, N.Y.
1	LINDE	87 MG OF LOX	YOUNGSTOWN, O.
2	LINDE	87 MG OF LOX	ECORSE, MICH.
1	LINDE	217 MG OF LOX	ESSINGTON, PA.
1	LINDE	87 MG OF LOX	DEER PARK, TEX.
2	LINDE	217 MG OF LN_2/LOX	PITTSBURG, CALIF.
1	LINDE OF CANADA	131 MG OF LOX	SAULT STE. MARIE, ONT.
1	N.A.S.A.	125 MG OF LOX	CAPE CANAVERAL, FLA.
1	N.A.S.A.	56 MG OF LN_2	CLEVELAND, O.
1	N.A.S.A.	35 MG OF LN_2	CAPE CANAVERAL, FLA.
1	N.A.S.A.	64 MG OF LN_2	GREENBELT, MD.
3	N.A.S.A.	75 MG OF LOX	NIMBUS, CALIF.
2	N.C.G.	35 MG OF LOX	CHICAGO, ILL.
1	ROCKETDYNE	100 MG OF LOX	SANTA SUSANA, CALIF.
3	ROCKETDYNE	220 MG OF LOX	EDWARDS AFB, CALIF.
1	ROCKETDYNE	300 MG OF LN_2	EDWARDS AFB, CALIF.

LH_2 STORAGE (–423° F)

AIR PRODUCTS	200 MG	LONG BEACH, CALIF.
AIR PRODUCTS	200 MG	LONG BEACH, CALIF.
AIR PRODUCTS	90 MG	INDIANA TOWN, FLA.
AIR REDUCTION	100 MG	PEDRICKTOWN, N. J.
DOUGLAS AIRCRAFT	90 MG	NIMBUS, CALIF.
DOUGLAS AIRCRAFT	90 MG	NIMBUS, CALIF.
LINDE	342 MG	ONTARIO, CALIF.
LINDE	44 MG	TORRANCE, CALIF.
LINDE	750 MG	SACRAMENTO, CALIF.
N.A.S.A.	100 MG	NIMBUS, CALIF.
N.A.S.A.	100 MG	NIMBUS, CALIF.
N.A.S.A.	227 MG	MERCURY, NEV.
N.A.S.A.	110 MG	MERCURY, NEV.
N.A.S.A.	105 MG	NIMBUS, CALIF.
N.A.S.A.	70 MG	MERCURY, NEV.
N.A.S.A.	250 MG	NIMBUS, CALIF.
N.A.S.A.	250 MG	NIMBUS, CALIF.
PRATT & WHITNEY	90 MG	UNITED, FLA.
ROCKETDYNE	560 MG	SANTA SUSANA, CALIF.
ROCKETDYNE	90 MG	SANTA SUSANA, CALIF.

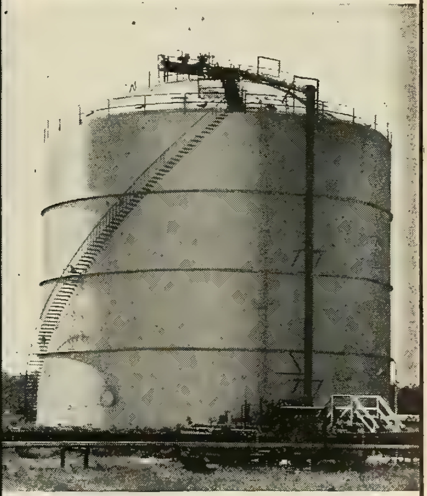
LNG SHIPMENT AND STORAGE (–259° F)

CONSTOCK, TANKER— "METHANE PIONEER"	32,000 BBL LNG	OCEAN TANKER
CONCH, TANKER	170,000 BBL LNG	OCEAN TANKER
METHANE TANKER LTD.	170,000 BBL LNG	OCEAN TANKER
CONSTOCK LIQUID METHANE	35,000 BBL LNG	LAKE CHARLES, LA.
NORTH THAMES GAS BOARD	16,400 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	16,400 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
C. A. duMETHANE LIQUIDE	69,189 BBL LNG	PORT ARZEW, ALGERIA
C. A. duMETHANE LIQUIDE	69,189 BBL LNG	PORT ARZEW, ALGERIA

*Capacity is expressed in thousands of Gallons (MG) or Barrels

Spherical storage for liquid oxygen, nitrogen, hydrogen and ethylene.

Liquid natural gas shipment by sea using rectangular aluminum tanks to hold liquid methane.


Flat-bottom tanks used for storage of liquid nitrogen, oxygen and methane.

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of composite materials having variable density and variable thermal properties. Composites have been prepared in the laboratory with a bulk density variation from 20 to more than 100 lb./ft.^{3}

—For any specific application, the composite can be tailored to provide desired thermal characteristics at a weight that is competitive with or less than that associated with conventional homogeneous materials.

—In some instances, the material can perform both as the heat shield materials and as the structural member itself.

Pershing Effectiveness Grows

FORT WINGATE, N.M.—The Army's Martin *Pershing* missile can hit a target area the size of a football field from a 200-mi. range with a highly reliable guidance system that is one-third lighter than the predecessor *Redstone's.*

Reliable sources indicated these features of the missile's effectiveness as the Army last week fired another off-range tactical shot into White Sands Missile Range, N.M., 230 n. mi. away.

It was the eighth such shot from
here. Five have been fired fro
Blanding, Utah.

White Sands spokesmen said tha
the lessons learned in the series o
Pershing firings from Wingate an
Blanding will be valuable in the com
ing *Athena*-launched ABRES (Ad
vanced Ballistic Re-entry System
tests from Green River, Utah, earl
next year. These will be the longes
tests over populated areas within th
United States, and will involv
trickier safety and range instrumen
tation problems.

Firings from the Blanding an
Wingate points enable the Army t
field-train missile battalions over
broad-range spectrum from abou
150 to almost 400 mi.

A close estimate of *Pershin*
guidance weight is about 100 lbs
compared with *Redstone's* 150 lb
Much of the weight saving wa
achieved in the *Pershing* ST-120 sys
tem by reducing the size of the gyr
platform carrier ring.

Some weight saving was also ac
complished through a module ap
proach in the amplifier unit.

A still lighter unit is under stud
according to spokesmen for the Ben
dix Corp., guidance system contrac
tors.

The ST-120, an advanced descend
ant of German concepts, employs
stable platform about 18 in. in diam
eter, mounting three air-bearin
gyros and three accelerometers fo
slant range, slant altitude, and cros
range references. Weight of the ST
120 is about 50 lbs., and that of th
amplifier unit is about 20 lbs. The an
alog guidance computer weighs abou
30 lbs., according to educated est
mates.

Martin Co., *Pershing* prime con
tractor, reportedly is considering fu
ther simplification and reduction i
size of program and test componen
mounted on one of the four modifie
M-113 tracked vehicles which com
prise each battery.

Last week's Wingate firing fu
ther reinforced the Army's alread
firm assurance of *Pershing* reliabi
ity in flight over populated areas o
this country. The fort, with its roug
terrain, is regarded as ideal for mid
range firings and tactical maneuver

Army and industry spokesme
emphasized that cross-country ope
ations have failed to shake up groun
or missile components enough t
cause any substantial problems.

The successful shot last wee
was conducted by the Fourth Batta
lion, 41st Artillery. This unit wa
scheduled to fire two more missile
Thursday.

Last week's firings required ad
dition of a 16-in. section to the te

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket

Rocket nozzles and convergent-divergent cones made of Great Lakes Carbon Corporation's **HLM-85** grade graphite are standard in the first stage solid propellant motor developed by Thiokol Chemical for the Minuteman missile.

GLC's **HLM-85** graphite is distinguished by high density, great erosion resistance and economy of performance.

HLM-85 graphite is in full production. Ample supplies are available in a wide choice of sizes and shapes.

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Photo by Thiokol Chemical Corporation

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ssiles to carry added telemetry d destruct components. Other in- umentation simulated warhead de- ation by telemetry signal.

pe Wildcat Unresolved

Representatives of the RCA Serv- Co. and the International Alliance Theatrical and Stage Employees ll meet Dec. 9 in Miami to discuss d possibly resolve contract prob- ns that sent Cape Canaveral photo rkers out on a wildcat walkout t. 28.

The photographers' picket lines re ignored by most of the 30,000 ployes at the Air Force Missile st Center and NASA's Merritt and Launch Area until Nov. 12 en carpenters walked off the job, serving the picket lines. Many er building trade unionists were d off for lack of work that de- nded on prior work by the car- nters.

The contract differences to be cussed in the Miami meeting in- de 28 cents an hour in pay and out 100 demands made by the otographers. A spokesman for the otographers has threatened re- nption of the strike if a settlement is not reached and a new contract signed by Dec. 15.

The international president of IATSE has not sanctioned the strike and heads of local unions in the Cape Canaveral area appealed to their members to ignore the lines when they appeared.

Anti-Meteoroid Dust Studied

FARMINGDALE, L.I., N.Y.—A novel method to protect spacecraft from meteoroid impact is now under study at the Air Force's Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio.

The technique involves covering the vehicle with a layer of metallic dust about 40 in. thick, held in place between plates or grids by an electrostatic field. Studies are now under way, the Air Force reports, on means to vibrate the dust in order to shatter or vaporize impacting meteoroids.

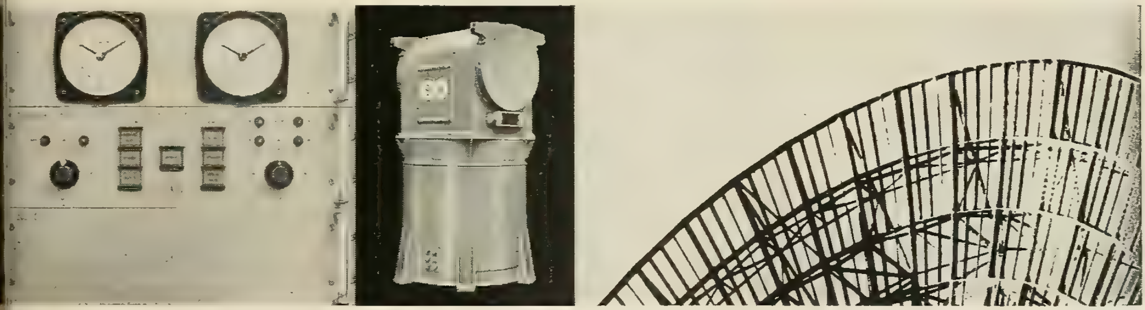
The project was revealed by Maj. Gen. Marvin C. Demler, commander of the AF Research and Technology Div., in a speech before the Second Annual Symposium on Unconventional Inertial Sensors, held here last week under sponsorship of the Navy's Bureau of Weapons, the AF Systems Command's R&T Div., and Republic Aviation Corp.

Demler, outlining the activities of his division, also noted that the new high-power radar facility now being installed at the Rome, N.Y., Air Development Center will begin limited operations this month. The new facility, which will provide 1.5-million watts of RF output, is expected to be fully operational late next year.

Demler also told the symposium that if weather conditions are favorable, AF scientists from the Avionics Laboratory at Wright-Patterson will attempt an eight-hour flight late this month from the Panama Canal Zone to Dakar, West Africa, to check out new concepts for a manually operated back-up space navigation system for low-orbit operations.

The flight, in a KC-135 test aircraft, will proceed along the great circle route above the equator, the Air Force says, so that Earth-environment test of the space system can be reduced from a three-dimensional problem to one of two dimensions.

Other AF and DOD officers attending the two-day conference reported privately that though some researchers in the field of unconventional sensors may not agree, the most significant factor from the



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Scientific-Atlanta, Inc. SA

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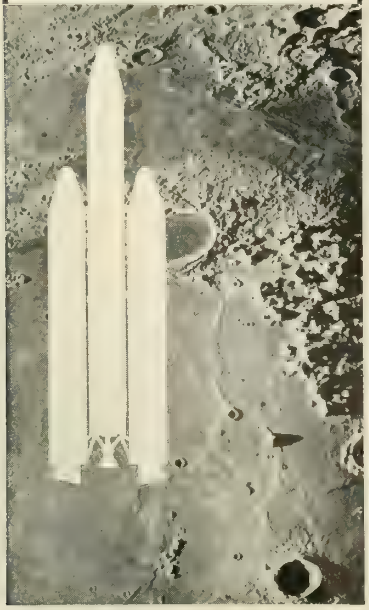


customer's viewpoint, in pursuit of these devices is likely to be cutting production cost.

There is still an emphasis on improved performance, they point out. However, the feeling within some government agencies is that the real payoff in any unconventional system which moves to fruition will be due to reduced costs, possibly by as much as a factor of 10.

AF officers also noted that there is some wasted effort in this field due to firms trying to catch up to others already far advanced in some areas. It is felt that unconventional sensor design is one area where "leapfrogging" technology can be accomplished.

Though a wide range of approaches are being pursued, government sources say that laser and nuclear sensors are, for the moment at least, the systems which are "most talked about."

JFK Visits Cape

President Kennedy's Nov. 16 visit to Cape Canaveral included a close look at a *Gemini* spacecraft and a trip to Complex 37B, where he saw the *SA-5 Saturn I* on its launch stand.

After inspecting the Saturn facility, the President's party flew over the *Titan III* launch complex being built on Banana River and NASA's industrial and launch facilities under construction on Merritt Island.

The helicopters then headed for sea and the aft deck of the USS Observation Island missile support ship where he watched the atomic-powered submarine Andrew Jackson launch the *Polaris A-2* from beneath the surface of the ocean. The missile flew about 1,300 miles and was termed "very successful."

It was Mr. Kennedy's third tour of the Cape during his three years in office.

Pan Am Studying Signatures

The U.S. Army has awarded Pa
American World Airways a $1.
million, three-year contract to co
duct spectrum signature measur
ments on Army radar and commun
cation equipment.

A group of about 60 enginee
and technicians has been assigned
perform the work at Ft. Huachuc
Ariz., and at the Ft. Bliss-Whi
Sands Missile Range area.

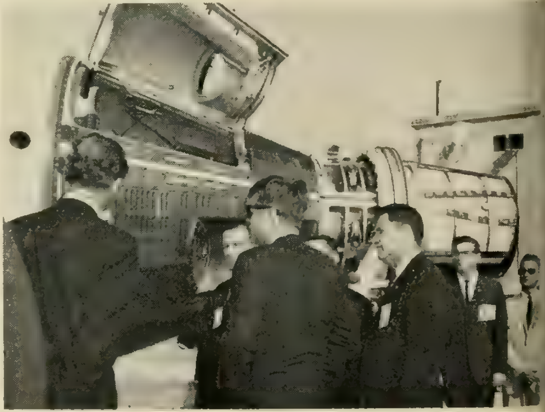
Headquarters for the group h
been set up at Ft. Huachuca, whe
Pan Am has been working on t
Electronic Environmental Test Fac
ity (EETF) project.

"Spectrum signatures," which a
as distinctive as human fingerprint
will be taken from radar equipme
at Ft. Huachuca, while the commun
cations equipment measurements w
be made on the Ft. Bliss-White San
range.

The effort forms the Army's co
tribution to the Department of D
fense Tri-Service Radio Frequen
Compatibility program, which w
initiated several years ago in
effort to reduce radio frequency i
terference in the military.

Military Space Discussed

The military role in space is
subject "generally misrepresent
and largely misunderstood," sa
Maj. Gen. B. I. Funk, command
of the Air Force's Space Systen
Division. Funk told a recent Wor
Affairs Council gathering in Los A
geles, that the nation's policy of r
serving space for peaceful purpos
"serves to put the military into spac
not restrict space to purely non-mil
tary activities. Whatever shape a
direction our ventures into spa
ultimately take, military consider
tions cannot be separated from t
political, economic, psychologic



VIEWING GEMINI capsule, left to right; Sen. George Smathers (D-Fla.); Astronaut Gordon Cooper; President Kennedy; and G. Merritt Preston, head of MSC office at the Cape. Others in background are unidentified.

technological and sociological implications of space development," Funk said.

Military resources, facilities and capabilities have been and are continuing to be well represented in the national space program, said the SSD chief. "The extent of this military participation and the degree to which it contributes to our success in space is not generally recognized, but it nevertheless exists."

USSR Predicts New Satellites

The Soviet news agency Tass last week reported that the Soviet Union is planning to put artificial satellites into orbit around the Moon, Mars and Venus "in the near future."

Prof. Gleb Chebotarev, head of the applied cosmic mechanics department at the Theoretical Astronomy Institute of the Soviet Academy of Sciences, made the statement in an interview with a Tass correspondent.

"The regions of outer space around the Moon, Venus, Mars and Mercury, where stable movement of artificial Earth satellites is possible, have been determined by means of electrical machines at the Theoretical Astronomy Institute," Chebotarev reportedly said.

The scientist said the calculations for Mercury were merely theoretical.

Lilienthal for Private Atoms

David E. Lilienthal, first chairman of the Atomic Energy Commission, has delivered another sharp indictment of what he terms "the continuation of a government-supported and dominated atomic industry and technology."

Lilienthal, now chairman of the Board of Development and Resources Corp., speaking before the American Nuclear Society in New York last week, called for "an orderly, but very prompt return of the development of this new technology into private, competitive, non-governmental hands. Under our system," he said, "it is only under the pressure of the most extraordinary public need that the development of a new technology is an appropriate or traditional task for the government.

"I asked in 1950 and I ask again what would have happened in the development of the internal combustion engine, or electronics, or the telephone, if these emerging new technologies were as closely tied to a federal scientific bureaucracy, and to the Federal treasury, and to a Congressional committee as is the case with the non-military atom?"

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PUSH-BUTTON PCM SYNCHRONIZER

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This exceptionally stable and highly accurate synchronizer accepts a serial PCM signal at rates up to 1 mc, automatically conditions the incoming data and generates a stable clock signal.

Automatic circuitry adjusts to input signals over a 40 db dynamic range. The unit incorporates a unique digital loop filter that maintains bandwidth proportional to bit rate at all frequencies. Output of the synchronizer is a reshaped, noise-free, serial PCM signal and a set of clock signals phase coherent with the output data.

The BRS-1—which can be remotely-controlled—performs the functions of data regeneration, format conversion and serves as the "front-end" for any digital telemetry system.

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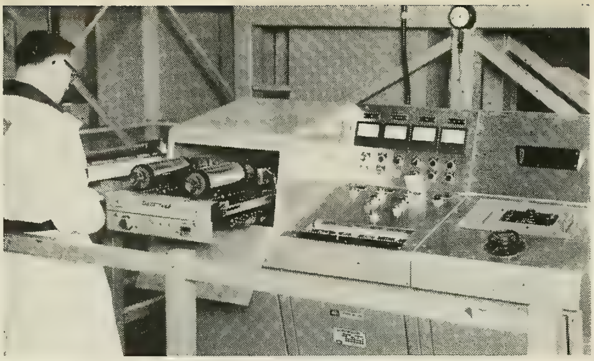
This machine is designed to produce polar, helical, geodesic and circumferential winds—or any pattern that can be identified mathematically. Through a data track system, computer-developed winding patterns can be produced with extreme accuracy, under completely controlled environmental conditions.

Included in the new facilities are winding machines for smaller structures, and large presses for molding rubber and plastic insulators. All associated materials control, curing, finishing, inspection, and testing are likewise provided in the new plant.

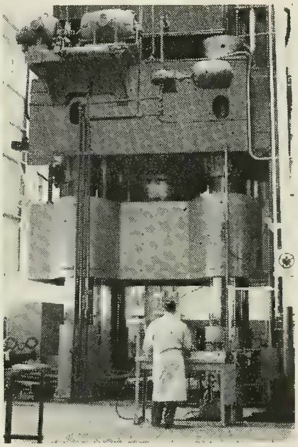
This complete service can help you in designing and producing light, strong, heat-resistant structures. Applications include rocket motor cases, nozzles, and pressure vessels.

Write for a copy of the new booklet "Large Filament-Wound Structures." *B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Dept. MR-11, Akron, Ohio.*



Data Track console feeds programmed instructions to large winding machine.

35-foot high oven is used for curing structures under automatic control.



5000-ton press is used for making insulators for solid propellent rocket motors.

B.F.Goodrich

aerospace and defense products

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477,714 miles

477,714 miles round trip to the moon . . . . . . The National Aeronautics and Space Administration has as a goal the most complex engineering task yet attempted by man . . . . . the landing of men on the moon and their safe return to earth. Five years have elapsed since this goal was established—five years of intense, dedicated work. NASA is continuing its all-out effort to surmount the engineering obstacles, and now the completion of the first steps toward the exploration of the moon is in sight. Government agencies and aerospace contractors have been formed into a smooth-working team to assist the space agency in this lunar project. The successful completion of this program depends upon team effort. Brown Engineering Company, Inc., long a member of America's aerospace industry, has developed and grown in technical knowledge and experience, and now offers highly specialized services in aerospace research, engineering, and manufacturing. We are proud, indeed, to be playing an important role in America's greatest engineering project.

BROWN ENGINEERING COMPANY, INC.

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missiles and rockets volume 13 number 22 november 25, 1963

SPACE PROGRAM'S SECOND PHASE: DEVELOPING TECHNOLOGY FOR FUTURE

THE U.S. HAS WON its spurs in space and is now embarking on the next, vastly more complex, phase of exploration of the near Universe. Soviet Premier Khrushchev has reaffirmed for the benefit of those who may have doubted it that Russia intends to maintain and expand her lead in space; President Kennedy has made it equally clear that the United States will press forward with its program to be first on the Moon and beyond. NASA Administrator Webb estimates that completion of the space program already begun will cost the U.S. $35 billion—with a $1-billion-a-year penalty for dallying (see p. 37). In its Third Annual NASA Issue, MISSILES AND ROCKETS *reports on the space agency's progress and planning in advanced research, technology and development for such projects as the orbiting space station, lunar base, manned Mars expeditions, unmanned exploration of the Sun and distant planets, and intense examination of the Earth environment. Part I covers technological requirements; Part II funding and contracting; Part III advanced programs; Part IV installations; and Part V is a useful directory of NASA officialdom.*

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Pioneer in the design and development of command and control systems, MITRE was chartered in 1958 to serve only the United States Government. The independent nonprofit firm is technical advisor and system engineer for the Air Force Electronic Systems Division and also serves the Federal Aviation Agency and the Department of Defense.

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WEBB:

WE ARE MOVING FROM PREPARATION TO FRUITION

THE ANNUAL NASA issue of MISSILES AND ROCKETS affords a good opportunity to assess the progress we have iade and the major problems we face.

In the first five years of NASA's existence, we have cquired the experience and built up the technological base equired for an effective and well-balanced national space rogram.

We are now entering a period of intensified development f the more advanced rockets and spacecraft and ground acilities needed to give the United States clear leadership i space exploration and space use before this decade is out.

We are moving from a period of preparation to a period f fruition. In our Fiscal Year 1964 budget request, less ian $50 million was asked to start new projects.

During the coming years, billions of dollars will be spent i workshops and laboratories, at test sites and construction tes, in preparation for the flights that will take place in roject *Gemini* and the *Saturn-Apollo*-Moon program. For xample, we have estimated that half of the cost of the *aturn-Apollo*-Moon program will go for testing rockets, pacecraft, and equipment on the ground, before flight. inety percent of these expenditures will go to pay American idustry for work performed under contracts—work that ill add greatly to the competence and competitive position f our national industrial base in those areas most important) national security.

During this period of intensive research and develop- ient, it becomes doubly important for industry, the press, nd NASA to tell the workshop and test site story as well as ie launch site story. The role of the space engineer must e brought out as clearly as the achievements of space cientists and the astronauts.

We are now in a much better position to judge the cost f the NASA space program for this decade. To bring all irrent projects to completion will cost about $35 billion, icluding the approximately $7 billion already obligated since ie beginning of Fiscal Year 1961. Of this, about $20 billion is to cover the *Mercury, Gemini,* and *Saturn-Apollo*-Moon programs and related support activities. Fifteen billion is to cover our projects in space sciences, applications, and advanced research and technology.

Of the $20 billion for manned space flight, $18 billion is being spent on increasing our competence in orbital operations and rendezvous and docking techniques in the area most vital to our national security, near-Earth space.

Only after some 2,000 hours of experience in Earth orbit are logged in *Gemini* and *Apollo* will the lunar exploration mission be undertaken.

The additional cost of the lunar mission is estimated at about $2 billion, including $1,135,000,000 for unmanned exploration of the Moon with *Ranger, Surveyor Lander,* and *Lunar Orbiter* spacecraft; $390 millon for development of the Lunar Excursion Module (LEM), or landing craft; and $400 million for related development, such as integrating the LEM with the *Apollo* spacecraft system.

These cost estimates made after two years of experience with the program are as reliable as we and our contractors can make them—if we can maintain the momentum of our present effort and do not get involved in the waste of slow-down and stretch-out. We have estimated that every year's delay in completing our current programs will cost at least $1 billion extra in overhead. Moreover, only completed facilities and hardware can serve the nation.

The main question of space policy before the nation today is whether we will continue to move ahead on the only schedule which gives the United States a chance to attain leadership in the vital field of manned space flight by 1970.

Every newspaper reader saw the headlines in late October which said "Khrushchev Withdraws from Moon Race!", or words to that effect. But I wonder how many readers saw what Khrushchev said at the cosmonaut wedding reception a few days later:

What Khrushchev said at the wedding reception was neither ambiguous nor oblique. According to press dispatches, he boasted:

"Even our opponents realize that we have the leading role in space. They haven't overtaken us yet, and we're not going to let them.

"Our people are covering themselves with glory. We shall give the capitalist world no peace, since it has to go."

WE IN NASA believe this nation has no intention of starting and stopping our space programs according to what the head of the Soviet government says from week to week. But I do believe that what Khrushchev said at the wedding is what he really has in mind regarding space competition.

The primary responsibility of the government-industry-university space team is to bring all our current programs to a successful conclusion at the earliest practicable date. No other investment this country could make at this time would give us more space strength in less time than the *Gemini* and *Saturn-Apollo*-Moon programs now under way.

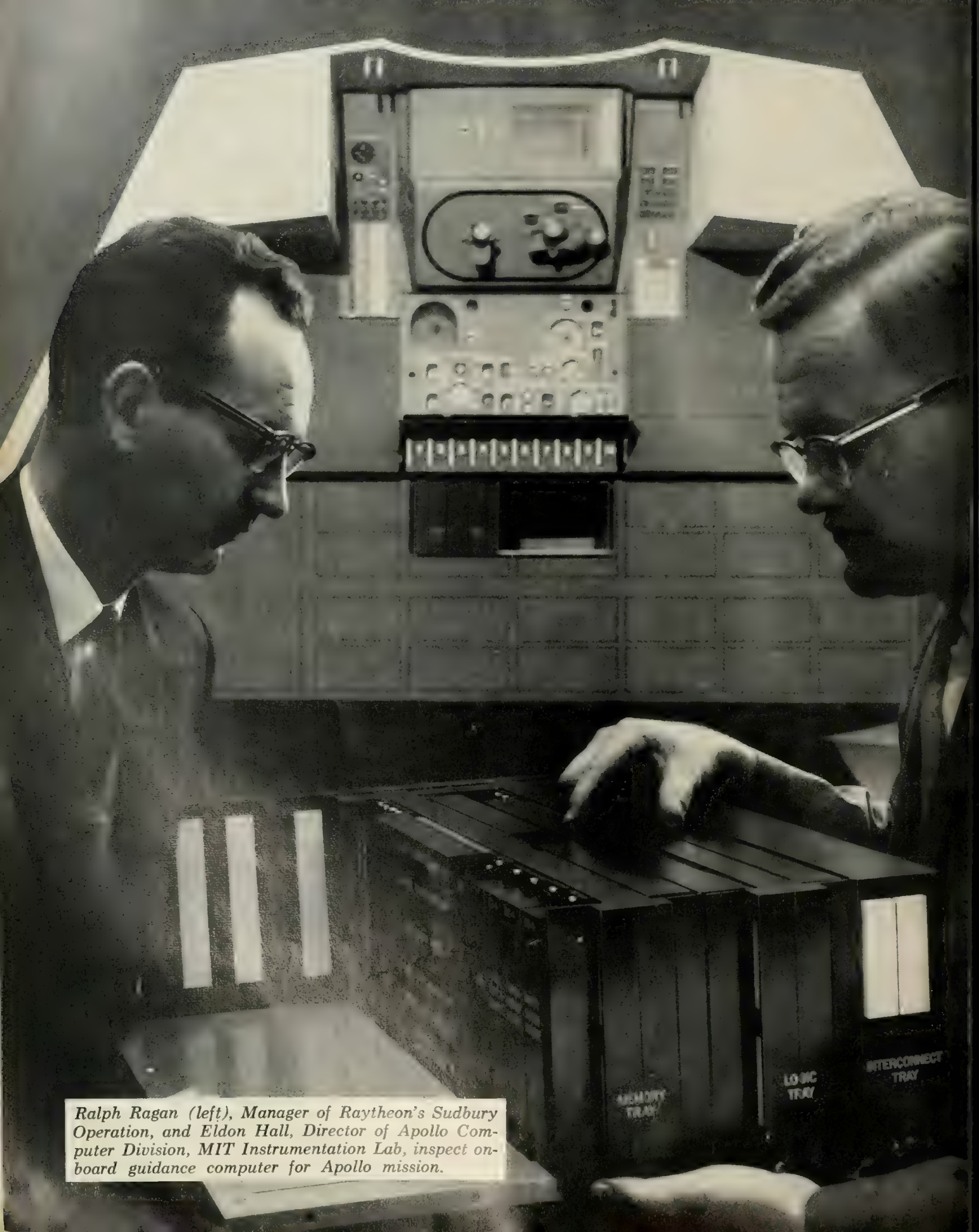
As the major space projects of this decade go into their final stages, important decisions must also be made concerning what new efforts our national interest will require in the years ahead.

World leadership in space cannot be gained, or long maintained, by any single achievement or program. The Department of Defense and NASA are presently studying what our next major projects in space should be. On the basis of these studies, recommendations will be made to the President through the National Aeronautics and Space Council.

James E. Webb

MIT/RAYTHEON STATUS REPORT:

APOLLO Guidance


MEMORY TRAY
LOGIC TRAY
INTERCONNECT TRAY

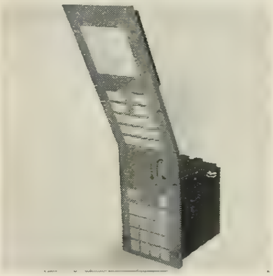
Ralph Ragan (left), Manager of Raytheon's Sudbury Operation, and Eldon Hall, Director of Apollo Computer Division, MIT Instrumentation Lab, inspect onboard guidance computer for Apollo mission.

Predicted Reliability Increased More Than 2:1 ... Contract On Schedule

By incorporating the latest rope memory module and integrated micrologic techniques into Apollo's on-board guidance computer, the MIT/RAYTHEON team has *doubled* predicted reliability of the system with no loss in scheduling time.

Drawing upon a background of successful joint effort in developing the reliable Mark 2 Polaris missile guidance computer, the MIT/RAYTHEON team is striving for similar fault-free operation of its Apollo guidance system. The operating computer, less than 1 cubic foot in size, will provide midcourse navigation and guidance data for NASA's Apollo spacecraft mission.

The MIT/RAYTHEON-developed computer contains an extremely dense, low-powered, fixed memory of 5,000 bits/cubic inch. In flight, the astronaut will operate the computer through a 16-button coded keyboard. In case of input error or an "unacceptable" order, a light will warn the astronaut to erase the error. When the command is correct, he pushes an "enter" button and the computer will take over, using inputs fed to it automatically from the other subsystems in the craft.



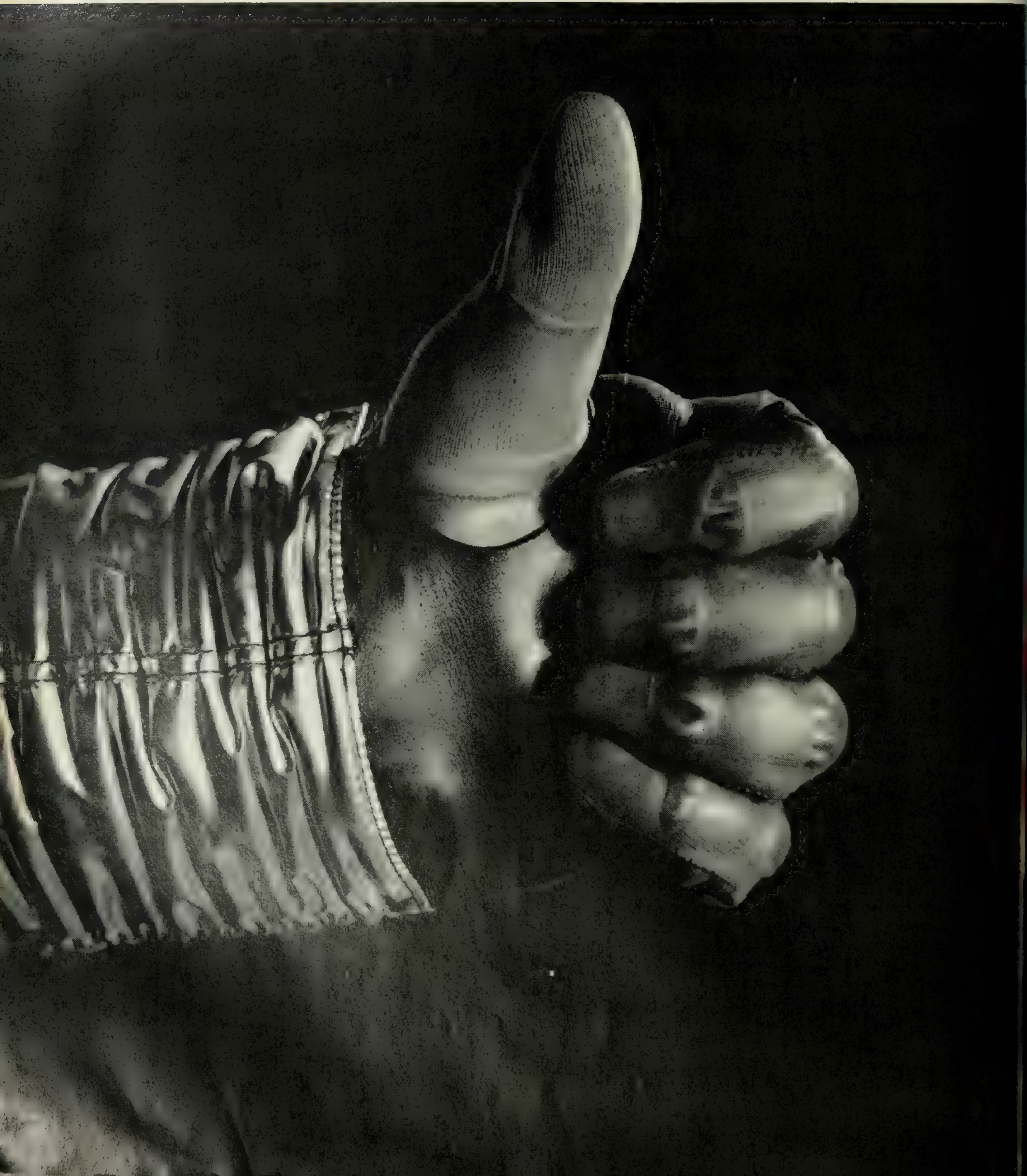
Keyboard for Apollo's on-board guidance computer.

The working relationship of the MIT/RAYTHEON team in developing and producing the computer, its displays and keyboard, and its pre-flight ground support equipment, represents a truly unique capability in space age guidance and control. *Space and Information Systems Division, Sudbury, Mass.*

RAYTHEON

Tests conducted by Republic Aviation Corp., Farmingdale, N.Y., under a contract awarded by International Latex Corp., developer of the suit for United Aircraft's Hamilton-Standard Division, NASA's prime contractor.

The other day, at Republic Aviation's Life Science Labs, where we are running the life-support and mobility tests on the Apollo Space Suit, somebody asked the guy in the suit how the tests are going, and he said:



THIRD ANNUAL NASA ISSUE

Part I

ADVANCED RESEARCH & DEVELOPMENT

Communications, Tracking to Mushroo

NASA'S EXPENDITURES for advanced research in electronics and control, authorized at just over $30 million for Fiscal Year 1964, probably will double within the next four to five years, say top space agency officials in this area.

Efforts will be spread over a wide technological base, but the development of advanced techniques for communications and tracking will no doubt expand more rapidly than the more traditional areas of electronics research.

Direction of the total NASA advanced research effort in electronics and control flows from the offices of Dr. Albert J. Kelley, director of E&C within the Office of Advanced Research and Technology (OART).

Kelley's domain encompasses a large number of small tasks—about 2,500 individual projects spread throughout several NASA centers, industry, universities, and non-profit laboratories. About 80% of all tasks are accomplished out-of-house. In effect, his office and staff do a "systems job" on the total electronics research effort, "making sure we wind up with a balanced program." The office monitors all research at the centers, reviews it to insure against redundant effort at separated facilities, approves both the tasks and the dollars that go with it, and, from a vantage point on top of the overall electronics picture, suggests areas of research that would be worth exploring.

"We stay somewhere between 5-10 years ahead of the projects," Kelley told MISSILES AND ROCKETS. "We want to keep the bin full for the project people, turning over projects as they are needed in current programs and moving on to new areas."

Kelley's office also has led the fight for development of an Electronics Research Center for NASA, which is viewed within OART as inexorably tied

AC SPARK PLUG technician tests bellows of Apollo Command Module for leakage. Assembly permits optics to work in space.

Electronics Tab Reaches $60 Million

o the ability to meet future space elecronics requirements with the needed onfidence in system reliability.

OART electronics and control bascally splits the broad technology into our areas—guidance and navigation, ontrol and stabilization, communicaion and tracking, instrumentation and lata processing.

GUIDANCE AND NAVIGATION

OART's efforts in guidance and avigation include both active and assive sensing units, inertial compoents, guidance computers, displays, nd trajectory analysis.

Within the inertial component reearch, the two major efforts involve ryogenic and electrostatic gyro develpment.

The cryogenic gyro supports a gyro otor using a superconducting magnetic t cryogenic temperatures to produce a nagnetic field which requires no elecrical energy after initial establishment. Until recently, NASA reports, cryogyro evelopment has been inhibited by maerials problems. For example, engineers ay that magnetic flux trapped in the yro's spherical niobium rotor causes ddy current losses and drag, causing he gyro to run down.

As a result of work directed by Marshall Space Flight Center, with conractual support from General Electric, rogress is being made in both the maerials and the material finishing area. An attempt probably will be made to se this type of device in a cryogenic uel environment aboard a space veicle. This would put it into the desirble "living-off-the-environment" cateory which NASA is attempting to ecure for many systems.

The device, according to NASA, ow operates at about 4°K liquid heum temperatures, and they "would like use the cryo-gyro without further ooling." The system could also be suported by new schemes for cryogenic omputers.

- **Joint interest**—The electrostaticlly supported gyro and accelerometer, hich is receiving considerable fiscal support from both NASA and DOD, needs no cryogenic environment but does require a high-vacuum internal environment. Performance figures on many of these devices are classified, but NASA engineers say their performance to date is "acceptable." Development efforts on these devices will continue, aimed especially at improving ability to withstand higher g-loads (this also is true of the cryo-gyro). Procurement of some evaluation devices has begun.

Trends and Problems Covered in This Article

- Broad "living-off-the-environment" concepts for components, systems and computers
- New dog-on-the-leash guidance systems and very low-g accelerometers for electrical propulsion guidance
- Hardware development resulting from advanced rendezvous sensor study
- Possible use of triangular libration points for rendezvous and rescue trajectories
- Flight projects SCANNER and RAM
- Possibility of a new Guidance Evaluation Satellite
- Problems of stabilizing laser platforms in space
- New wobble damping needs for space stations
- New wireless telemetry type techniques to cut down on spacecraft wiring
- Laser needs and possibility of two major new contracts
- MIROS over-the-horizon laser relays
- Move to small-dish phase arrays to replace large single dishes in the DSIF
- New VLF interplanetary communications
- Detailed rundown on instrumentation needs, covering everything from new Sun sensors and magnetometers to digital transducers and increased emphasis on tried-and-true analog devices for certain applications
- Data processing, an area which could see a major evolution away from electronic systems to fluid computers using air or various fluids
- New interest in Japanese systems, adaptive systems and a breakdown of computer memory requirements

Interest in longer life and more severe environmental operation for gyros and accelerometers will cause an expansion of research into other ionized-particle (both atomic and micron size) measuring devices.

[For a complete report on advanced concepts in the gyroscopic and accelerometer area see the MISSILES AND ROCKETS Special Report on Guidance and Control, Oct. 7.]

Within what NASA categorizes as passive devices, two major new development areas are of particular importance. These involve development of the so-called "dog-on-the-leash" type of tethered electro-optical space navigation scheme, and the requirement for a new breed of accelerometer extremely sensitive to the very low accelerations which will accompany introduction of electric propulsion systems into planetary travel. Both of these areas represent considerable potential for industry.

The dog-on-the-leash scheme is basically an attempt to hang a guidance system out of the spacecraft, attached only by a dual-purpose connecting cable. This might take the form of space sextant operating with an advanced gyro system, possibly electrostatic.

- **System advantage**—There are a number of advantages to such a system, NASA notes. First of all, the crew will not have to maneuver the spacecraft in order to take celestial fixes. The craft can remain drifting and, as long as the cable is not tangled, there will not be any large mass to rotate. Stabilization of a small sextant platform away from spacecraft disturbances may improve navigational accuracy and shift the requirement for fine stabilization from the heavy spacecraft to the lightweight platform. Furthermore, the system avoids eclipsing the optics with the spacecraft frame.

NASA admits that this is a radical and "somewhat risky" approach, and adds that it has "no real idea of what it would cost to develop such a system if it were feasible." Ames Research Center is doing most of the in-house effort for the space agency. Ames has also contracted with GE for development of an optical system suitable for this application. Within the next 18 months, NASA says, it hopes to have evaluated the optics and be in a position to connect the gyros to check early performance.

The criticality of accurate acceleration measurements during very-low-thrust trajectories was pointed out recently in a report by Lewis Research Center describing a 415-day Mars mission using an electrically propelled spacecraft. Errors of ½ deg in thrust angle would cause about a 200,000-mi. position error. A 1-deg error in thrust magnitude would cause a 30 ft./sec. velocity error.

To guard against this, NASA needs very-low-g (on the order of 10^{-6}-10^{-12} g's and better) sensing devices. Many avionics firms say they have developed instruments of this type, but the situation is confused by the real lack of devices which are capable of verifying instrument performance at these very low g levels. MSFC reportedly will undertake a study of evaluation techniques for these devices.

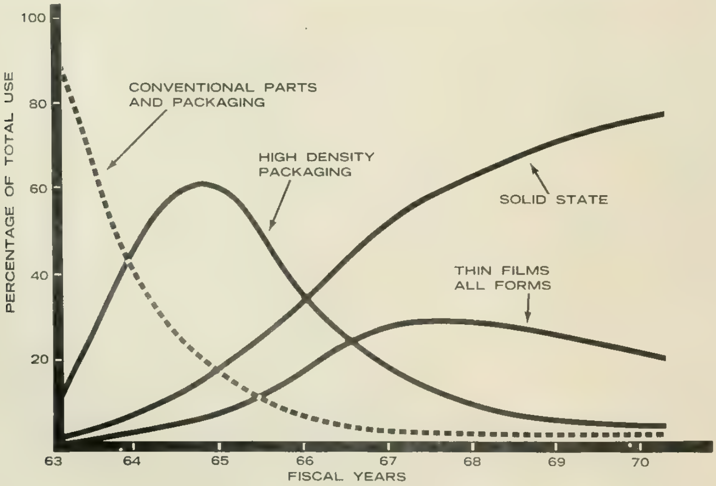
Also, though no funds have been required to date, NASA is known to be pushing for a *Guidance Evaluation Satellite* to aid in solving these and similar problems.

- **Sensor studies pushed**—Another important part of OART's electronics research is embodied in a study of advanced rendezvous sensor requirements. NASA started out on this last year, funding Cornell Aeronautical Laboratories, Westinghouse, and Raytheon to look at the problems and the known requirements and—perhaps more importantly—to provide some insight into the "unknowns." Results of studies have been submitted to MSFC, which will handle the follow-on activity.

Out of this study, NASA expects some hardware development will flow, probably not in the form of complete systems, but rather key subsystems such as antennas and transmitters. Included may be laser rendezvous sensors, ionizing particle radiators, and development of prototype landing altimeters based on various forms of nuclear radiation. Initial hardware development is expected to begin after the first of the year and will be open to industry.

In other optical navigation schemes, both Langley and Ames Research Centers will continue active programs. In addition to R&D on highly precise systems, NASA will expand efforts to develop simplified hand-held visual and photographic sextants for back-up and emergency use.

In the guidance computer area, OART will fund new research into development of pneumatic computers, perhaps acting in conjunction with air-bearing gyros.



Prediction of microelectronics usage for aerospace applications.

Industry and university support of trajectory analysis problems is also expected to rise as the space program moves beyond the *Apollo* planning stage. On a mission to Mars, a spacecraft would be in a spiral trajectory for about 139 days to accelerate to escape velocity, spend 223 days in a transfer trajectory partially coasting and partially thrusting, and 53 days in a capture spiral ending in a Mars orbit. The requirement for analysis of interplanetary flight is immense. In-house activity by NASA is high, and there is a definite de-emphasis of lunar trajectory analysis.

NASA will also pay more attention to possible use of natural triangular libration points in space as a means to effect spacecraft rendezvous or perhaps rescue missions. These points are ones of equal gravity at specific locations between the Earth and Moon. NASA will study ways to launch which will enhance a spacecraft's ability to wind up at these points if they so choose.

- **Horizon sensors**—Of the few flight programs supported by OART's electronics and control directorate, Project *Scanner* may hold the key to the path which the space agency chooses in development of future horizon sensors. Though horizon sensing is critical for establishment of local vertical with respect to Earth, Moon and planets, and is also used for altitude functions by sensing the apparent change in appearance of the Earth's or planet's diameter, NASA admits that there is meager knowledge of the appearance of horizons to space-borne instruments.

One flight already has been made in *Scanner* and at least two more are expected beginning early next year. Using modified *Javelin* boosters, a spinning vehicle with several telescopes and sensor attachments aboard is lifted into a suborbital trajectory. The horizon can be viewed many times at various altitudes and with sensors operating at different portions of the spectrum on a single flight. From these flights, NASA hopes to learn how sharply the Earth's edge is defined—which will indicate accuracy limits for horizon scanners—and what regions of the spectrum (near or far infrared, ultraviolet, etc.) are most efficient for scanning. The program is being run by Langley.

The *Scanner* instrument package is designed to gather about 350 data points on each flight in several spectral bands, using sensors with about .03-deg resolution. The first flight, using relatively crude instruments (3-deg resolution), reportedly showed some advantage in the UV band.

CONTROL AND STABILIZATION

Though research money is still being spent on improvements to stabilization echniques that have been available for ome time, there is now a movement owards greater understanding of some f the more esoteric theories which underlie stabilization philosophies.

Within manned flight control, ASA will increase emphasis on underanding of the man-machine relationip, working closely with its Biotechology and Human Research Group. ew simulation capabilities will play a ajor part in defining optimum interces.

New funding, mostly to universities, ill support attempts to develop adanced control theory concerned priarily with the mathematical approach new control concepts. Major steps in pplied math in this field have been ade recently by both the U.S. and SSR.

Research into future adaptive conols, which NASA says will require on-linear compensation in the control ocess, will also be stepped up. MSFC ill study application of adaptive conols to large flexible vehicles, where ructural flexibility and fuel sloshing ill complicate matters. Ames will study ptimized control along a planned ourse in the presence of perturbations; angley is also studying optimum nonnear control systems.

• **Automatic flight control**—Typil of the improved automatic flight ontrol system studies, according to ASA, is the Ames study to uncoue the yaw and roll modes while nsing yaw errors in satellites slaved the center of the Earth. Ames is also udying new error signal detection ompatible with high-accuracy teleope-spectrometer pointing systems d a new method to provide passive amping using gravity gradient stabilition.

Recent development of a singleavity gradient damping mechanism hich, by cross-coupling, can be made damp about all three axes, may pave e way to what NASA considers its ext objective in this type of unmanned titude-control system—development a damping mechanism which will alw use of gravity gradient stabilization satellites at much higher altitudes, ssibly to synchronous heights.

Goddard Space Flight Center is deloping a control system using a moentum sphere as an alternative to flyheels for attitude control. Langley has veloped and flown a new simplified ntrol system, called Miniguide, for a inning satellite in a planetary orbit. e system consists of a telescope, IR nsor, and reaction jet. MSFC is deloping a control system using secdary injection techniques, in which e main engine thrust is deflected by side-injected gases. If this proves feasible for large engines, it could obviate the need for gimballed engines.

Development of manned space stations is certain to cause a major research effort into effective stabilization systems, especially with an eye towards new wobble damping techniques.

Use of dog-on-the-leash type guidance systems will also require highly accurate stabilization systems. Informed sources say this could probably best be accomplished with inertial wheels coupled with the optical and gyro systems.

• **Future sophistication**—Further down the road, the practicality of space-to-ground laser communications systems may hang on the ability to advance the stabilization state of the art by an order of magnitude.

Within the S&C area, NASA is also focusing increased attention on new methods of organizing electronic control systems which will introduce telemetry techniques to system design and lead to major reductions in spacecraft wiring and interconnections.

NASA is expected to begin a series of control simulation experiments next year in which discrete address plus-code data transmission techniques are applied. The expectation is that a new family of components will evolve which will interconnect a flight-control system without need of wiring. New research into new displays, also falling within the S&C domain, will focus on development of electroluminescent displays with integrated digital logic, on development of new all-attitude indicators with improved accuracy readout, and possible new projection-type displays which display horizon information completely around a spacecraft cabin.

COMMUNICATIONS AND TRACKING

Within the communications and tracking section of OART lies probably the greatest real and potential growth in funding over the next few years. Major projects, all critical to sophisticated manned spaceflight and unmanned probes, include development of communications techniques capability through plasma sheath black-outs, development of optical communication systems, improved ground antennas and arrays, and advancements in electronic circuitry and radiation-resistant components and circuits.

Blackout problems—NASA will expand both its ground and in-flight research in an attempt to find ways to communicate through ionized plasmas created around spacecraft re-entering the atmosphere at speeds as high as 50,000 fps.

Significant progress has been made in laboratory experiments. Evidence shows that when small amounts of atomized water are injected into an ionized flow field, the water can suppress the ionization, allowing normal radio communications. Experiments with other chemical additives will be carried out. Also, application of magnetic fields to alter plasma flow will be tested. Other experiments will be made with material additives such as freon and other special gases. The effect of ablative-type products from heat shields mixing with the plasma sheath during

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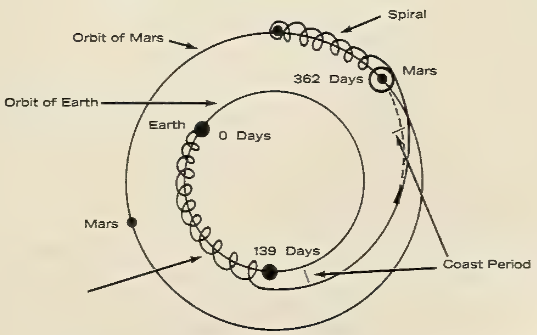

ERROR ANALYSIS

ERROR	EFFECT	CONCLUSION
22 lbs. in Vehicle Wt.	200,000 Mile Position Error	Repetitive Trajectory Determination and Corrective Guidance Maneuvers Required
½° Thrust Angle	200,000 Mile Position Error	
1% Thrust Magnitude	30 Ft/Sec Velocity Error	

re-entry also will be studied.

• **RAM flights held**—Backing up the laboratory program—primarily as a means to find out exactly what the plasma condition is, and eventually to test some of the proposed solutions in flight—is Langley's Project RAM (Radio Attenuation Measurements).

Three flights have already been made using modified *Scout* vehicles launched from Wallops Island. Four more flights are planned over the next 12-18 months.

Thus far, the flights have been attempts to define the optimum frequencies for communications through the plasma condition. Though some progress has been made, the space agency is admittedly nowhere near finding a means to communicate with vehicles traveling at *Apollo* re-entry speeds on the order of 36,000 fps. Use of higher frequencies will help if they can be put into realizable hardware. Use of X-band has been tested and was shown to work at re-entry speeds in excess of 25,000 fps (M/R, Oct. 14, p. 29). K-band, according to NASA, will probably be a little better and reduce the length of the black-out period. Optical systems, many believe, could eliminate it.

TECHNICIANS at IBM's Space Guidance Center, Owego, N. Y., check out mockup of Gemini simulator, which will be used to conduct human factors tests of spacecraft's inertial guidance system.

OPTICAL COMMUNICATIONS AND TRACKING

OART scientists are looking forward to the upcoming launching of the *S-66* satellite, with corner reflectors mounted on-board to allow laser tracking experiments, as the first major step toward accumulation of information on the feasibility of optical space communications.

Tracking measurements in range to an accuracy of 30 meters and in angular position to about 2 seconds are anticipated, according to NASA. This, they report, is about an order of magnitude better than any of the present electronic techniques.

With widespread participation, NASA hopes to accumulate data on various modulation techniques and frequencies. Also, with stations spread around the globe, data on absorption, scattering, diffraction, and polarization can be used to indicate optimum operational areas and techniques.

Despite the apparent gains to be accumulated by participation, scientists on the project are reportedly chagrined over the relatively small number of U.S. firms that have agreed to participate (M/R, Oct. 14, p. 9). European participation is said to be far greater. As one top scientist puts it: "I can't imagine why any U.S. company seriously interested in laser communications would not participate."

• **Research burgeoning**—For NASA, expansion of research in the optical communications field marks a major push to realize the enormous gains in available and usable communications spectrum, plus inherent size and weight gains, if a workable laser system can be developed.

Many experts are convinced that the answer to increased communications capability for very long space ranges lies somewhere between the pseudo-optical sub-millimeter and optical bands, with an optimum frequency lying between 10-100 microns.

Though scientists are enthusiastic about laser potential, there is a sober realization that a great deal needs to be developed before these systems become operational.

At the current time, gas laser systems appear to be a likely bet for early experimental use in deep space applications, since they can operate continuously and coherently at a single frequency. For operational use, solid-state CW systems would be far more desirable though power outputs would require tremendous increases. Recent observation of lasering action using Gallium Arsenide diodes showed potentially substantial increases in laser efficiency, but at this point these devices are viewed as much more applicable to specialized space-to-space communications, as lunar surface systems, and for geodetic satellite tracking. IBM, recently awarded a contract for an experimental laser communications system for probable use aboard *Gemini*, is expected to design around a GaAs diode.

• **Answers needed**—Usable and practical laser communications can be achieved only after a host of basic questions have been answered. Hardware must be developed, and efficiency must be improved from a current level of under 5% to perhaps 20% or better.

For example, NASA wants to know how large a ground receiver aperture can be used without losing the ability to receive coherently.

Some scientists speculate that about a 10-in. aperture may be maximum. If that is so, it could force designers to turn to non-coherent systems. To maintain coherence, an array of telescopes possibly could be used. Coherence takes advantage of improved overall efficiency and simpler demodulation techniques. Arrays, however, will mean more complex electronics.

To assure receipt of a laser beam, which may be several miles wide when transmitted from deep space, scientists also envision a group of arrays spread out over many miles so that a single atmospheric disturbance or cloud formation would not wipe out a transmitted signal.

With an efficient system, scientists estimate that lasers have a potential of providing about 20 to 30-db gain over microwave techniques.

To achieve about a 1-arc-sec. accuracy with a laser communications system, NASA scientists estimate, would require about a 5-in. optical system

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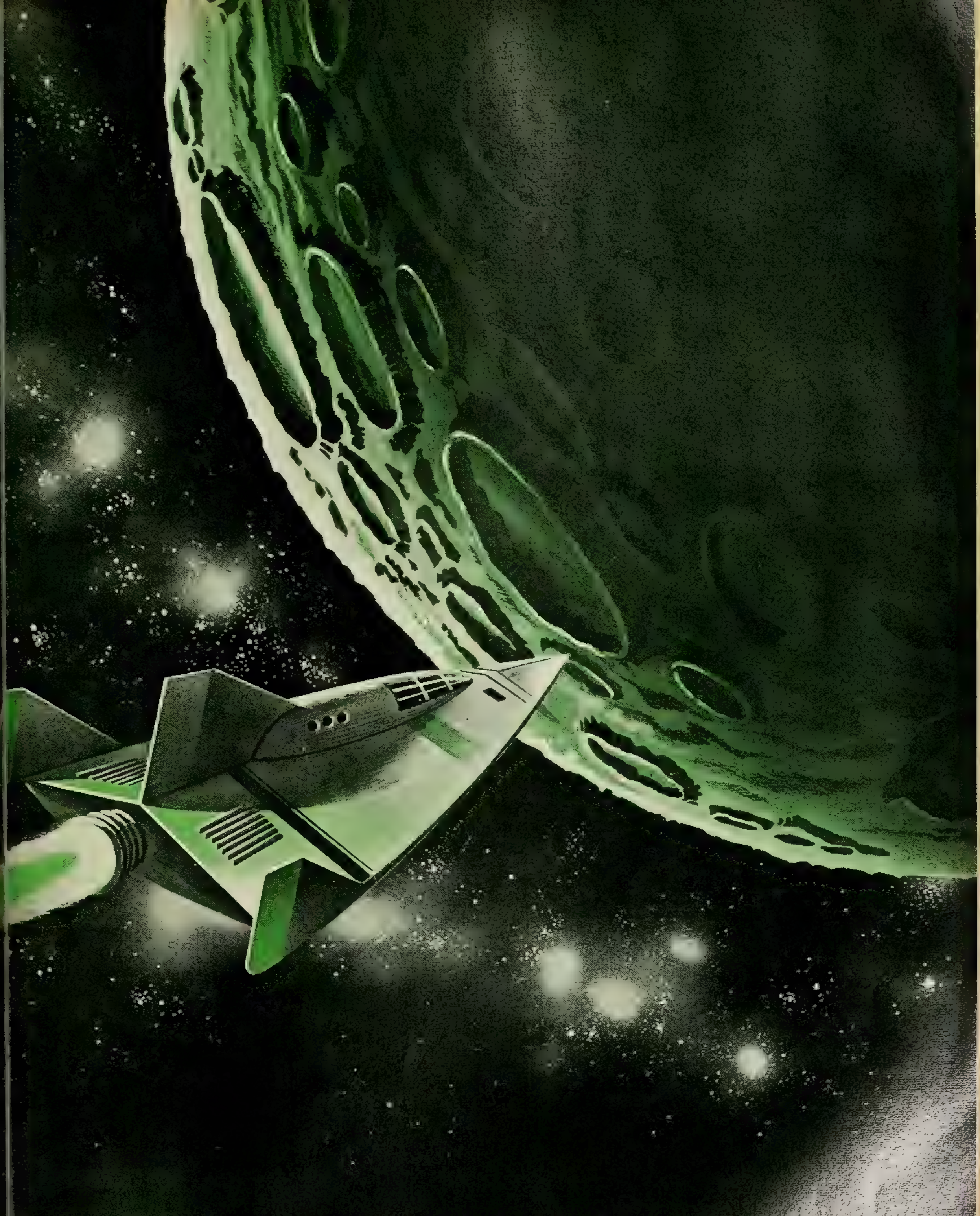

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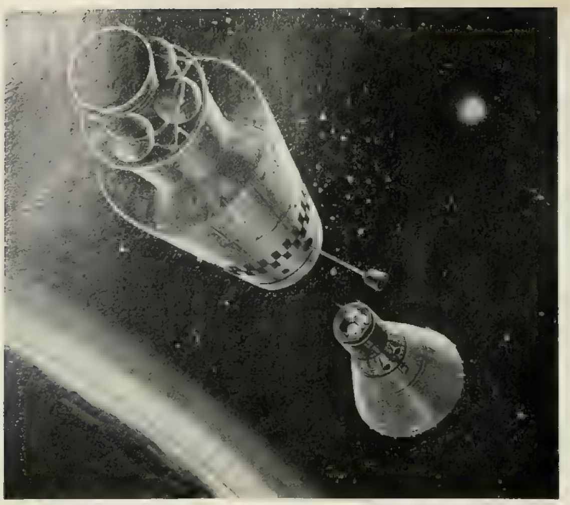

WESTINGHOUSE-Developed lightweight Gemini rendezvous radar is shown on front of spacecraft at right, aiding in docking with Agena.

aboard the spacecraft stabilized to about 1/10 sec. of arc, considered to be an order-of-magnitude advance in the stabilization state of the art. There is a possibility that the laser beam itself can be controlled to the final axis if the platform cannot be controlled to that degree.

- **Time factor**—Lasers as operational communications systems are still about 10-15 years away—if they materialize at all—but their appearance as experimental packages and as back-up devices will come much sooner. One factor that NASA says may be impeding growth is the lack of communications systems experts in the optical communications field.

The biggest single need today, says one top scientist, is a good laser for research purposes. "There is none available today which can make meaningful system and quantum noise measurements."

Brewing within the space agency are new studies that may turn up much-needed answers. One is the consideration of a broad approach, with industry support, aimed at development of such sophisticated optical components as waveguides, attenuators, couplers and mixers. It also is possible that several NASA centers concerned with laser development will get together, establish composite specifications on the type or types of lasers required, and then issue RFP's to industry for development. MSFC, GSFC, Jet Propulsion Laboratory, Manned Spacecraft Center and Langley would all probably participate. Action on this could come within the next two months.

OART is also exploring passive over-the-horizon laser communications relay links using modulatable corner reflectors aboard Earth-orbiting satellites. OART's *MIROS* (Modulation Inducing Retro-Directive Optical System) is already under way, with contracts let to Westinghouse and Philco. NASA reports some success already has been achieved. M/R has learned that NASA is considering RFP's early next year for development of a flyable *Miros*-type package which could ride piggyback aboard another satellite. Its concept involves relay action, which apparently can be achieved by on-board mixing of differently modulated (one pulse and one CW) transmitted beams.

Also coming under study will be relativistic effects when using optical frequencies from moving spacecraft.

NEW ANTENNA DESIGN

Major activity in antennas is centered on development of independently steerable, multiple-dish arrays, in preference to continued expansion in size and mechanical complexity of large single-dish antennas for deep space communications. Antennas are not likely to go beyond the 210-ft.-dia. dishes now planned for the NASA net.

Scientists within OART feel that the multiple-dish array, using relatively small antennas, is feasible and "is definitely coming." The space agency can be expected, probably in FY '66, to request funds for design and construction of a prototype array in order to begin collecting real data. Studies under way at Langley, with Stanford Research Institute support, are considering the size and number of antennas required and the dispersal.

- **Small dish advantages**—Advantages of the array of small dishes include, according to NASA, ability to use higher frequencies with correspondingly higher gain; greater versatility, in that dishes can be used as an array or individually; the fact that a single failure or even multiple failures will not shut down the station; and the likelihood of a wider tracking beam width.

NASA will also move into new studies on the use of VLF as a means for interplanetary communications (M/R, Oct. 14, p. 30). Ionized layers about the Sun and planets are thought to provide natural shields which in turn provide very low VLF (at about 15 kc) attenuation in space. The proposal envisions orbiting 3-mile-long VLF wire dipole antennas with transceivers around the Earth and another planet.

Other expanding OART research will cover development of high-gain vehicle antennas, re-entry antennas, and omnidirectional devices to aid track and acquisition during certain flight phases.

ADVANCED ELECTRONICS

Major effort in microelectronics will be directed at development of new active thin-film circuitry and further exploration of tunneling devices, both to achieve improved overall reliability and to provide circuit resistance to radiation. NASA's program will continue to expand in this area for several years, especially if and when an Electronics Research Center begins to function.

With reliable thin-film circuitry enhancing the concept of redundancy in circuit design, NASA will no doubt move toward use of "majority-voting" type of redundancy to an increasing degree in new systems. In this concept, three identical circuits may be used to convey the same data. At the terminal the outputs of the two circuits which agree are used, since they are likely to be most reliable.

INSTRUMENTATION AND DATA PROCESSING

Instrumentation is divided within OART, in general terms, between astrophysical, engineering, and biophysical instrumentation.

Within the category of astrophysical, NASA is interested in:

—*Radiation measurement devices*—Units able to respond to greater atomic particle velocity and mass ranges in planetary environments in which there are tremendous changes in electrons, protons, and neutrons over periods of time.

—*Sun sensors*—Solid-state devices capable of measuring from the short UV to far IR. NASA is said to be interested in studying certain bands in the UV star spectrum (below 1100 Ang.) and in the IR beyond the 8-1 micron area into the 25-50 micron range.

—*Solar probes measurement devices*—Systems extending exploration to within Mercury's orbit will require instruments capable of withstanding temperatures above 1500°F.

—*Magnetometers*—Several orders of magnitude beyond current devices will be needed, both at the low and high

Pelorus Ring (American—19th Century)—Courtesy Dossin Great Lakes Museum.

rom pelorus ring to spacecraft guidance

203 B.C., when Hannibal was recalled from Italy to fend Carthage against Scipio's legions, an alleged rate named Pelorus served as his navigator. His me now graces the Pelorus Ring, an instrument for king bearings and celestial azimuths.

nding one's bearings with a Pelorus is relatively simple; t establishing a fix in space is a complex problem. idance errors multiplied by the speed of spacecraft o cause complex problems, and are solved in milliconds by an AC inertial guidance system. AC is esently working on the inertial guidance system for e Apollo Command Module and proceeding rapidly on e application of inertial techniques for other planetstined space vehicles. In addition to this program, has been selected to provide the guidance for the TAN III, as it has on the TITAN II, THOR, MACE, and GULUS missiles. AC capabilities also extend beyond ese programs, as AC now provides navigation equipment for SAC B-52s and inertial components for the Navy POLARIS missile.

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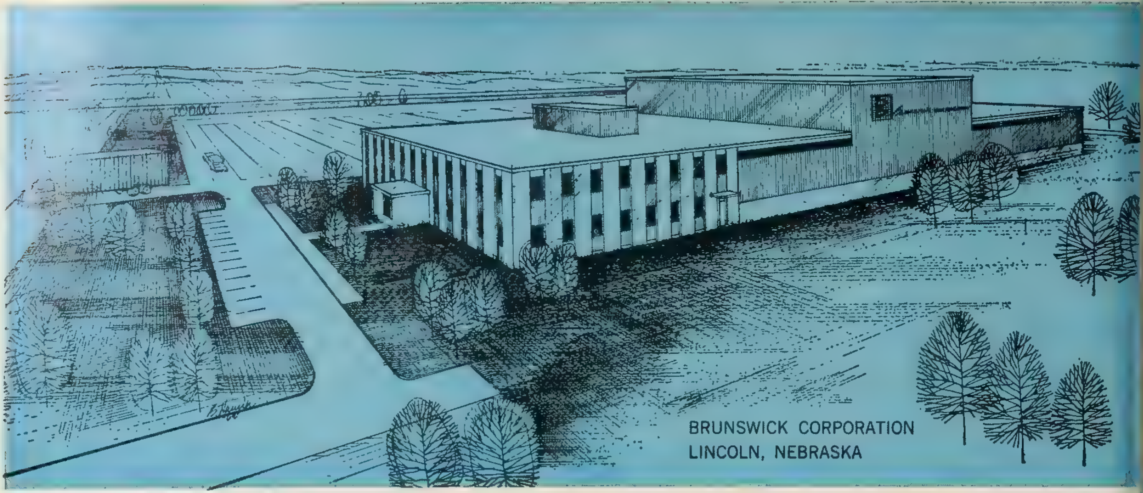

New Rocket Motor Case Facility

Brunswick's Defense Products Division will commence operation soon of its new Rocket Motor Case facility devoted to the fabricating of filament wound motor cases. This facility will utilize the latest techniques and equipment for rocket motor case production. Capabilities will include design, mandrel and insulator fabrication, winding motor cases, and hydrotesting of the completed unit.

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nd of the spectrum, although NASA ays the lower end is more important. Current state of the art in measurement of very low fields is about 0.1 gamma. At the upper end of field strengths sci-ntists hope to get as high as perhaps 00 gauss, though it may not be accom-plished with the same unit used for the maller field detection.

—High-temperature sensors—These eed to be extended beyond the cur-ent 5000°F level, says NASA. New evices to measure heat-shield ablation nd charring rates are needed. Con-ersely, new cryogenic temperature ransducers down to liquid helium levels re needed. Work on development of olid-state devices for this task is said o be well under way.

—Hard vacuum measurement—New chemes are needed for absolute meas-rement of ultrahigh vacuum beyond 0^{-10} levels to perhaps 10^{-15} mm Hg. oth ground and space instrumentation needed here.

—Fiber optics—Research probably ill be increased, in combination with lectro-optical devices, to improve ob-ervation in otherwise inaccessible areas. ASA may also try to apply other ad-anced optical techniques to measure-ent of small variations in gas density wind tunnel flows. Lasers with elec-o-optical shutter systems, being looked by Ames, may also lead to a new hotographic technique for measuring igh-speed range (Mach 20) phe-omena.

—Strain gauges—Also need exten-ion to higher temperature ranges for ind tunnel applications.

—Micrometeoroid impact devices—hese will see increased development, pecially by Ames, GSFC, and uni-ersities (M/R, Sept. 9, p. 22). Micro-eteoroid impact probabilities are be-nning to become known, primarily as result of *Explorer* satellite data.

—Digital transducers—NASA will ontinue its search for the elusive, truly gital transducer which, in many ap-ications, will drive away the complex-ies and certain unreliabilities of a-d onversion and provide ease of entry to computers and displays (M/R, ept. 17, 1962, p. 41).

Though results have begun to appear omising in this category, thanks to ew solid-state circuit availability, some ientists point out that there will be a ontinuing effort to improve and reduce size already highly developed analog ansducers and converters for special rposes where they are judged to be ore acceptable.

—Biomedical instrumentation—A sh will be made to totally eliminate res from body instrumentation, pro-ding much greater freedom of move-ent to the instrumented person or ani-al. In the offing is a small capsule which incorporates a microminiaturized sensing amplifier and battery and an FM spiral antenna to broadcast using telemetry techniques. Actually, NASA would also like to eliminate the battery by using a miniature receiving antenna which would pick up energy from a continuously operating transmitter in the spacecraft.

DATA PROCESSING

There may be major revolutions in store for the entire on-board data processing spectrum associated with the U.S. space program.

For example, OART is very hopeful that fluid computers, using pneumatic, hydraulic, or possibly cryogenic techniques, may replace electronically operated devices. General Electric is now doing a complete state-of-the-art survey on analog and digital fluid systems for MSFC, which reportedly will be completed in January.

These systems "very definitely hold promise for space," say top NASA scientists in this area. "There is also evidence that the Russians are very active in this area."

Fluid devices would "live off the environment" in that they would make use of on-board fuels or air systems. They promise extremely long life, are susceptible to no degrading effects such as radiation, and indicate very low wear rates. Essentially, the only degradations that can occur are physical results of jet impingement or irregular nozzle flows.

● **Fluid computers studied**—Use of fluid computers would offer lower speeds than are attainable with electronic devices, and probably would produce some increase in weight, size, and power. However, scientists say "it would be worth it to get away from radiation, temperature, and reliability problems inherent with many current electronic units."

Speeds in the order of tens of kilocycles are believed to be within reach, though the devices will probably never achieve megacycle speeds.

There is a possibility that fluid systems, probably smaller versions, could be combined with electronics packages, with the latter used as diagnostic devices.

Other important new possibilities are being discussed. NASA is known to be very interested in a new Japanese-developed computer called "Parametron," which is said to be a reasonably fast, simply configured, radiation-resistant unit, which uses phase oscillation present in circuitry to yield a binary output. NASA is "strongly considering funding in this area."

A major NASA contract let to Westinghouse to study sophisticated redundancy and self-repair schemes for computers may result in new design plans whereby modules can be automatically switched to replace failures.

● **Radiation resistance sought**—JPL is also doing important work for the space agency toward development of all-magnetic computers which would be inherently more reliable and radiation-resistant than the more conventional transistor devices.

In the area of computer memories, NASA is said to be looking for random-access, high-speed devices with capacities of about 10^7 bits and access times less than 1 microsec. Several important new concepts will be funded.

OART now has a contract with General Dynamics/Electronics in Rochester, N.Y., to investigate a new type of magneto-acoustic memory which could lead to development of a large-capacity, non-destruct, readout device for space use. The concept involves interaction of acoustic pulses with mechanical and magnetic properties of a material.

NASA reports that fresh funding is in the offing for a new ferrite memory which scientists believe may represent a significant "breakthrough" in achieving very-high-density memories.

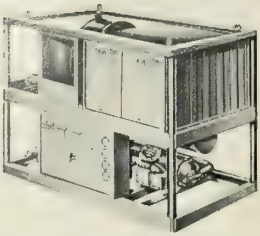
Other techniques being pursued include development of plated-wire memories by Univac, and additional thin-film and cryogenic memories being pursued by a number of films. In general NASA can be said to be emphasizing very high capacity with some sacrifice in speed.

High capacity for computer memories is in general associated with the coming-of-age of initial adaptive data-processing systems in which some learning capacity—hence big memory capability—will be required. Tied into the adaptive systems being evolved is the need for associative memory, another area where funding will continue and possibly expand.

NASA scientists are pointing to a recently completed study by Astropower, Inc., a subsidiary of Douglas Aircraft Co., Inc., which, using cloud pattern data developed by meteorological satellites, showed a realistic application of adaptive interpretation. NASA classed the Astropower report as "an outstanding job." OART, in addition to applications groups which are reportedly following these efforts closely, probably will fund additional studies.

NASA will also expand efforts to develop on-board data processing systems which are capable of delivering already highly-processed data to ground stations but which also retain the capability to deliver all data on demand. This requires large recording and memory capability which could lead to ultra-high-density electrostatic tape recording systems with densities of 10^8 bits per sq. in. ■

FROM AAF ENVIRONICS PRODUCTS OF ENVIRONMENT CONTROL PROGRESS



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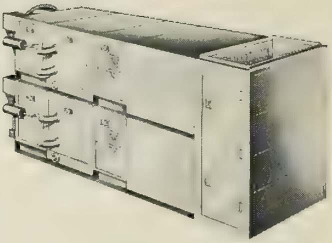

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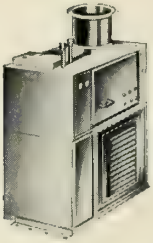
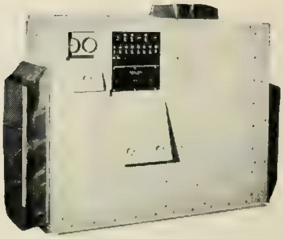
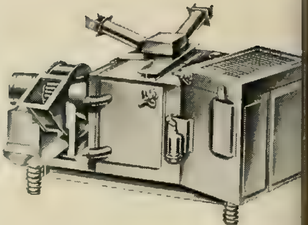


Emergency Cooling Unit. Contains DC-powered vaneaxial fan, DC-powered circulating pump, chilled water supplied air cooling coil, an AC-powered normal-service water circulating pump. Automatic controls for each component. Will withstand shock load in any direction.



Air Conditioner Unit. Provides fully modulated conditioned, filtered air supply with 3-stage cooling. 3-stage heating. Integral, finned, strip-type, electric resistance heaters. Cooling output: 42,000 BTU/hr., rated at + 125° F. Heating output: 51,000 BTU/hr.



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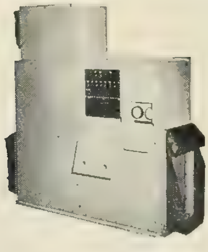

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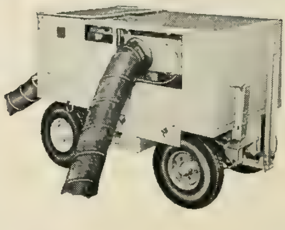

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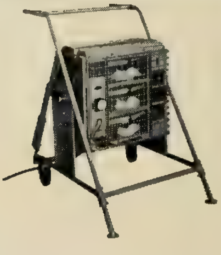

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KW. Adjustable angle. Removab
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man. Heater alone weighs 75 l

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NASA/advanced R&D

'All-Weather' Vehicles Goal of Structure Design

Materials must be improved to overcome challenges of re-entry heat, radiation, buckling and crack propagation

L-T-V ENGINEERS install heat shield on velocity package for Project Fire, a NASA re-entry study. Mounted on huge shaker, package will be vibrated to simulate some strains expected during flight on Atlas-D.

FUTURE SPACE VEHICLES' tructural and other design requirenents, going far beyond the mere statenent of strength needs, will depend reatly on the purpose and duration of ach mission and the degree of probaility that "exotic" loads will be enountered.

This is clear from recommendaons, made by NASA's Research Adisory Committee on Missile and Space ehicle Structures, to direct structural esearch toward "development of design nvironment spectra for each basic mison and each type of vehicle." The enre useful life of the vehicle is to be ncompassed in setting up these spectra, hich will include critical environnental effects and the order of their ccurrence, severity and duration.

When it comes down to the basic roblem of deciding whether a particur component or system design will ork satisfactorily in a future vehicle or system, "the most promising approach involves the use of reliability analysis and decision theory," says Lewis H. Abraham, Douglas Aircraft Co. engineer working with NASA's structural research committee.

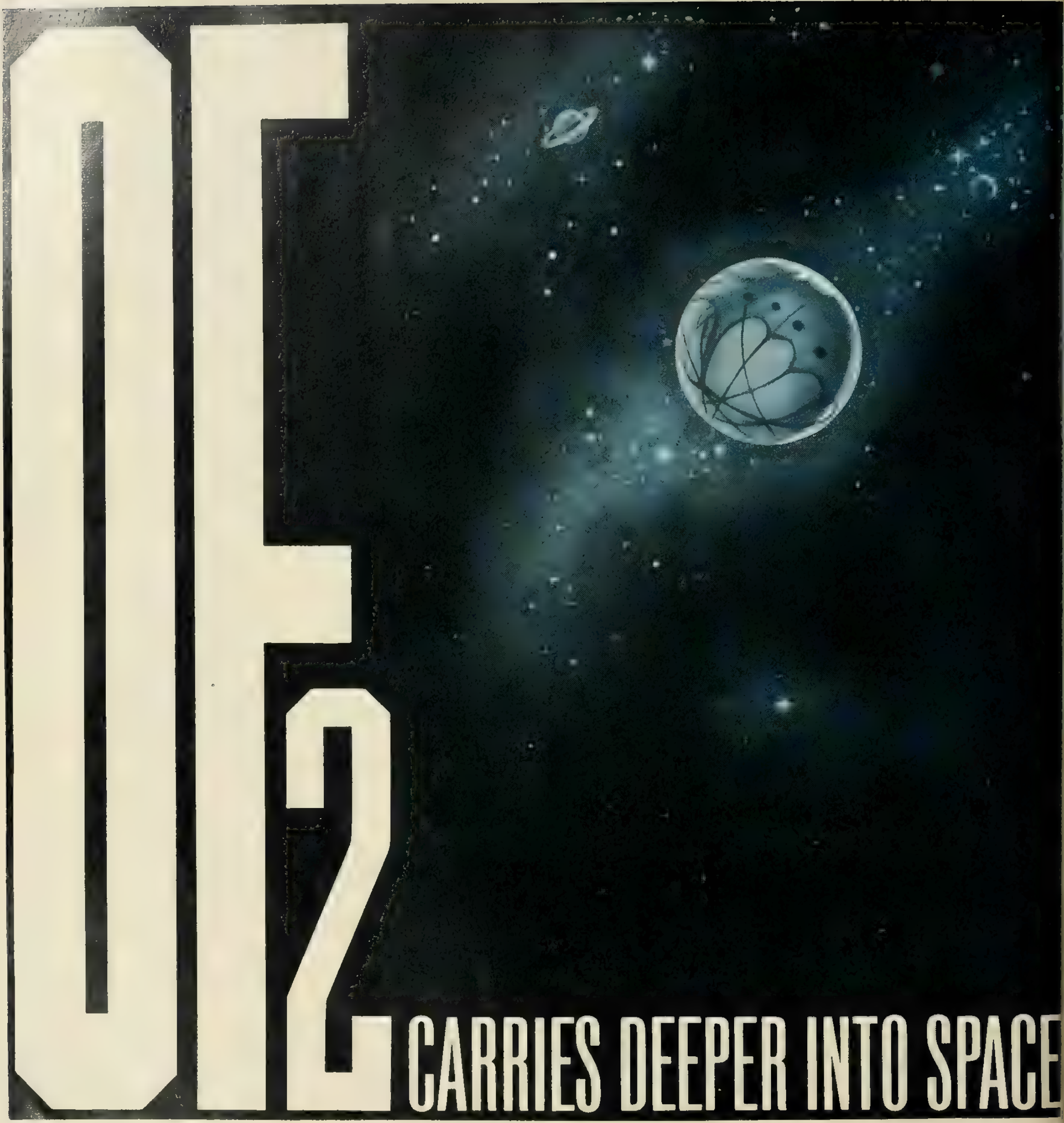
He observes that this approach requires specific statements of utility and degree of risk, and also requires that environmental data, loads and strengths be expressed in terms of means and deviations, rather than maximums and minimums.

"Greater reliability through better understanding of instability failures and fracture mechanisms offers a wide vista for research," says Abraham. He suggests that a good start would be development of basic analytical methods and procedures to formulate the statements of design criteria and utilities, and to integrate these with the acceptance criteria.

- **Structures**—The NASA structural research committee, summing up the requirements for advanced structural materials in a report to the space agency issued last month as TN D-2125, recommended:

—Improved materials for thermal protection of lifting surfaces, leading edges, nose caps and controls of lifting re-entry vehicles. For this purpose, the materials must have higher temperature capability than today's, better oxidation resistance, more ductility and lower cost.

—Pressure-vessel materials having increased ratio of tensile strength to density and better buckling resistance for solid-propellant rocket motor cases, propellant tanks and missile shell structures. These materials should be suitable for a wide range of temperatures and should have a ratio of ultimate strength to yield of 1.2 or more and a high ratio of Young's modulus of elasticity to density. More important than anything else,



Thiokol's OF_2 propellant technology promises larger payloads, longer missions

Because of superior performance, space storability and higher bulk density of oxygen difluoride propellant combinations, space vehicles should require less insulation, less tankage and interstage structure than advanced cryogenic systems. Resultant savings in weight and size can add up to greater payloads, longer stay-time on the moon or deeper missions into space.

Hypergolicity and other physical characteristics simplify OF_2 space engine design for improved system reliability.

Two years of research, including over 60 test firings at performance approaching 100 percent of theoretical, puts Thiokol in the forefront of OF_2 engine technology. For more details, write Thiokol.

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says the committee, is that the materials have a low density.

—More effective materials for shielding against geomagnetically trapped electrons and protons and against solar flare protons. There are also needs for improved data on the overall attentuation of such energetic particles, including effects of secondary radiation production, and on the frequency and depth of penetration of meteoroids in various materials in the space environment.

—Better techniques for designing with brittle materials, including better heories of fracture mechanics, better evaluations of brittle material properies and better methods for preventing crack propagation.

• **Zero gravity**—"We need 'all-weather' flying in space just as we needed—and got—all weather flying n the atmosphere during World War I," said Milton B. Ames, director of pace vehicles in NASA's Office of Advanced Research and Technology. He described the agency's broad objective as calling for space vehicles able to fly nearly any time or any place with the ame safety for passengers that aircraft ave today.

Adding detail to Ames' theme, Ernest O. Pearson, Jr., NASA's assistant director for environmental effects and aerodynamics, and Ralph May, special assistant in the same area, pointed up the engineering problems brought up by the "exotic" conditions in space, problems that NASA must solve before man can travel freely.

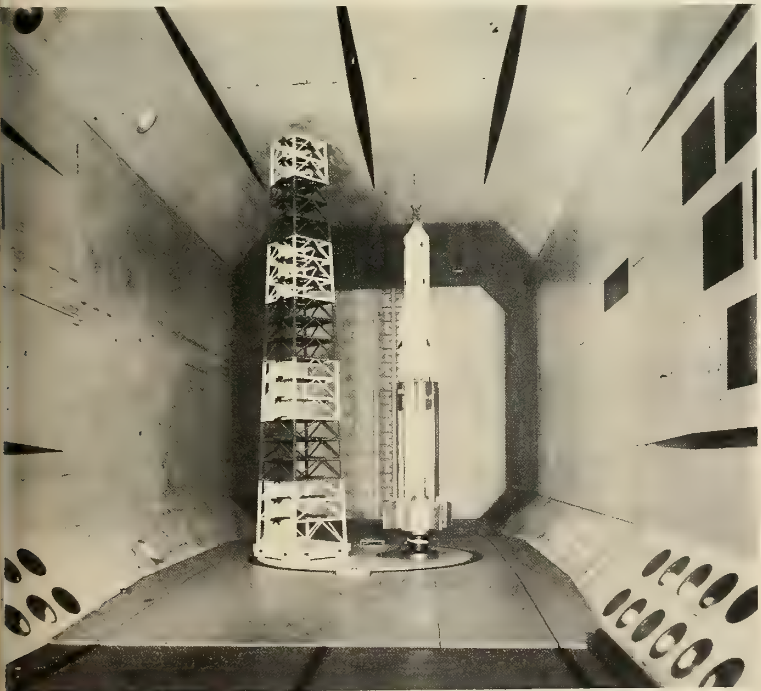
"Take zero-gravity," Pearson suggested. "How do you control and know the behavior of fluids in tanks?" The answers will influence the design of fuel tanks for space vehicles as well as the water tanks and any other environmental tanks needed by astronauts.

For this reason, NASA is backing studies to determine how to locate bubbles in a contained liquid in a zero-gravity field. It has been found, for instance, that suitably placed baffles can hold bubbles by surface tension regardless of tank orientation. The general problem is to work out the dynamics of a fluid system where surface tension is the predominant force. Other factors entering into the analysis are the contact angle of the fluid with the baffles and, for a practical system, the heat-transfer characteristics of a cryogenic fluid, particularly when held in fuel tanks exposed to Sun and shadow.

• **Radiation shielding**—The energetic particles poured into the upper atmosphere by nuclear testing are bringing up shielding problems adding to those anticipated from the Van Allen belts and solar flares.

Following high-yield, high-altitude bursts, nuclei of intermediate atomic weight are thrown off, many of them

EFFECTS of ground winds determined on aeroelastically scaled model of Saturn I Block I launch vehicle and Apollo spacecraft and its escape system, through tests run in Langley Research Center's transonic dynamics tunnel.



SATURN S-IVB...

Career challenge for SCIENTISTS AND ENGINEERS

The Saturn S-IVB stage is a key element in the U.S. Manned Lunar Program. An S-IVB vehicle will be used to thrust the manned Apollo spacecraft into earth escape-trajectory to the vicinity of the moon. Apollo's first orbital and re-entry tests will utilize the S-IVB vehicle prior to the final development of the Saturn C-5 Launch Vehicle.

ELECTRONIC SUPPORT

Utilizing automatic computer controlled checkout systems, the electronic support equipment for the Saturn S-IVB vehicle must provide maximum pre-launch checkout in the shortest possible time. Basic system design concepts, facilities planning, checkout philosophy, and data retrieval and display are currently being formulated.

Douglas is seeking electronic support specialists with experience in total computer design, color TV display, logic design, or other related areas who can meet the Saturn S-IVB challenge in initial design, hardware design and development tests. Send your resume to Mr. W. S. Ames, Douglas Missile and Space Systems Division, 3000 Ocean Park Boulevard, Santa Monica, California.

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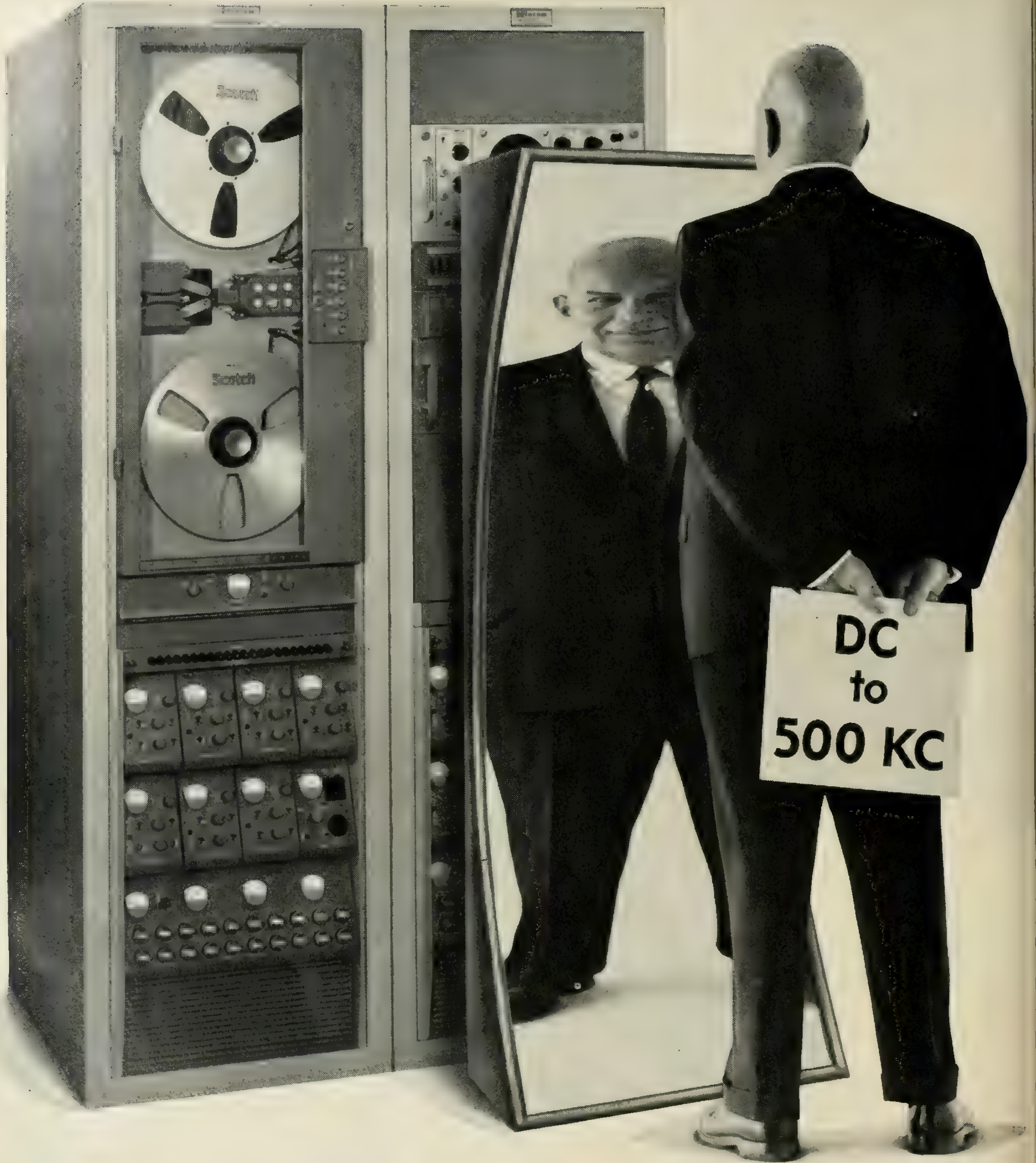

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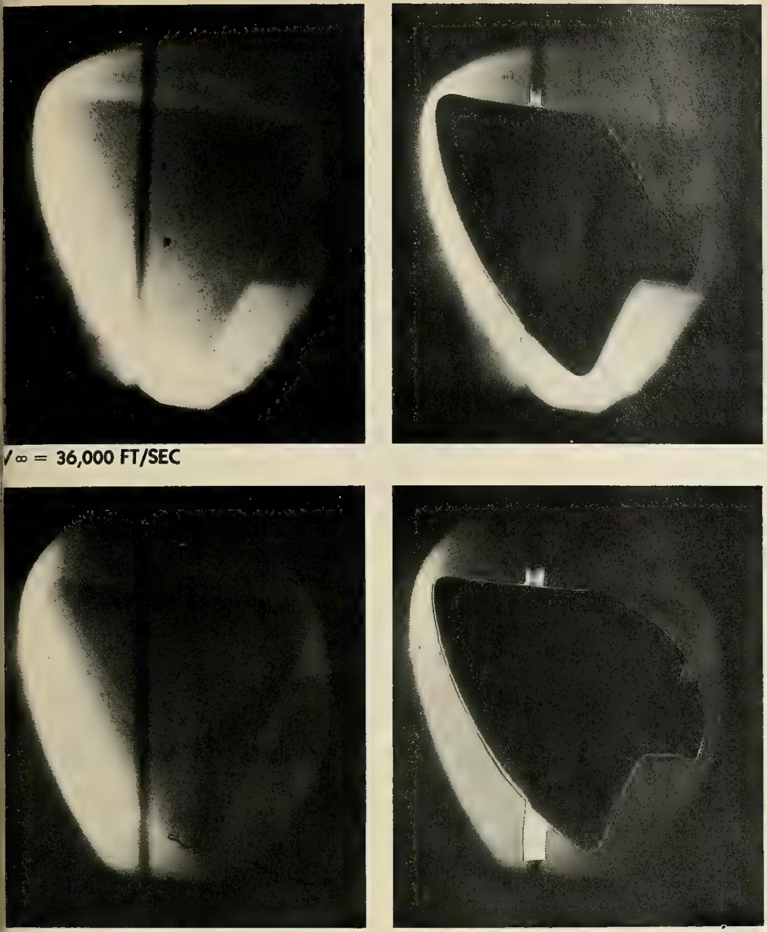

/∞ = 36,000 FT/SEC

/∞ < 36,000 FT/SEC

ON SHEATH around Apollo-type shapes observed in pilot model of Langley's expan- ion tube facility (30° angle-of-attack).

adioactive and decaying with the re- ease of energetic electrons and gamma ays. The paths of the charged particles, controlled in the main by the Earth's nagnetic field, are helical ones around he magnetic lines of force and form an rtificial radioactive belt.

The life of this man-made belt is nuch longer than was at first suspected. Latest NASA estimate is that it could ast indefinitely and will be a radiation hazard for at least the next six or seven ears.

Reflecting on the problem, an agency cientist said "we did know that glass vould discolor and transistors would ose their amplification in radiation belts. We also knew that solar cells vould degrade. What we didn't know vas that the artificial belt would be so ntense or long-lasting."

The belt dips down over the South Atlantic—the so-called "South Atlantic nomoly"—irradiating every passing ve- hicle. At roughly 200 miles' altitude, a vehicle would be in this artificial belt, which merges with the Van Allen belt and becomes indistinguishable except for types of particles.

Practically every orbiting vehicle in low Earth orbit will go through the anomoly at least once a day unless the craft is on an equatorial orbit. If a vehicle tries to stay out of the artificial belt by flying low, it must pay the price of increased drag. If, on the other hand, the vehicle tries to rise above the belt, it ends up in a Van Allen belt, which itself has been augmented by nuclear-explosion particles.

Thus, new shielding problems have arisen, for man and instruments. Man will be affected, however, only during orbits of long duration, not for the *Mercury*-type flights, according to NASA scientists. In *Mercury* trips, astronaut irridiation is "of concern, but is not critical because only a very low dose is involved." The *Apollo* flight is not causing any problem because of the astronauts' low dwell time near Earth, but the problem is considerably altered for space-station personnel.

Asked for an example of where the radiation belt caused a problem in in-

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PROPULSION

The lunar mission of the S-IVB depends on the use of high performance cryogenic propellants in a main propulsion system capable of engine start at a stage separation and re-start in orbit for the Apollo escape. Attitude control during earth orbit and escape requires a positive expulsion storable propellant system for intermittent operation under zero gravity. Propulsion requirements on S-IVB demand advanced design concepts in automatic checkout, modular pneumatic and propellant components, positive expulsion devices, and zero systems.

Douglas is seeking propulsion specialists who can meet the Saturn S-IVB challenge in initial design, hardware design, and development tests. Send your resume to Mr. W. S. Ames, Douglas Missile and Space Systems Division, 3000 Ocean Park Boulevard, Santa Monica, California.

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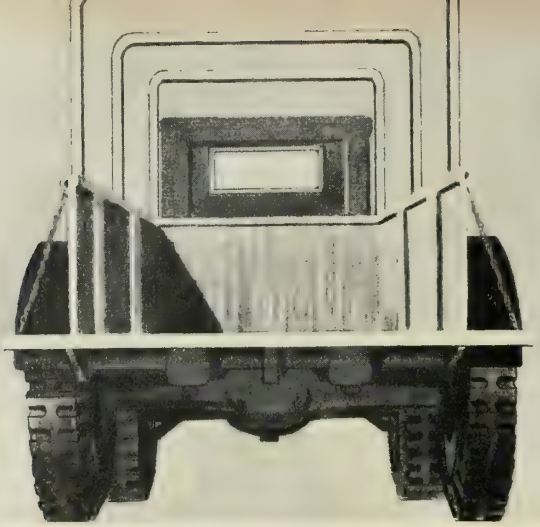
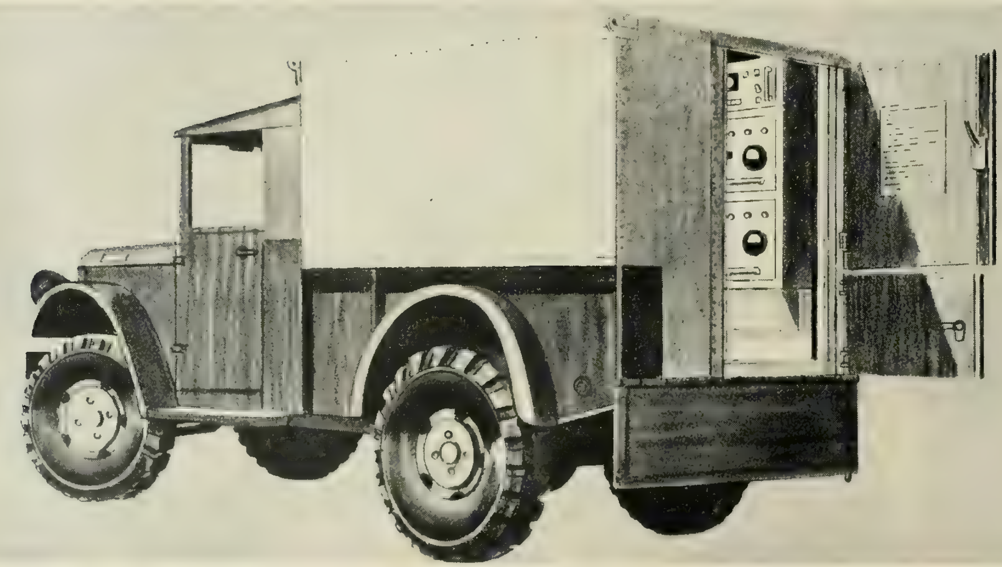


Could you put a 50 kw transmitter in this space?



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Other applications include underground and underwater installations, where equipment must operate unattended for long periods.

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trument design, Pearson mentioned the neteoroid detector, based on the change n condenser capacity for determining when a particle strikes. Unfortunately, he condensers are also discharged by nergetic electrons, thereby giving spurious pulses. "Right now we are trying to lter out these spurious signals," said Pearson, "and it looks like we can because they seem to have signatures different from those of the usual impact of meteoroid."

• **Planetary re-entry**—It is certain hat planetary re-entry shapes will not ook like *Apollo*. This is the conclusion f NASA scientists who say that the ifference in planetary gravities, atmospheric densities and even atmospheric onstituents will bring up aerodynamic nd control problems radically different rom those encountered during Earth e-entry from a lunar mission.

These problems are being studied, ut with the severe complication that we do not know for certain what either he Martian or Venusian atmospheres re like. Nevertheless, NASA does know hat any Mars probe will have to be ghtweight and therefore depend on elatively unsophisticated controls for lanetary re-entry. Pearson said that Venus will bring up even more difficult roblems because minimum practical ntry velocity into the planet's atmosphere will be 40,000 fps or more, as ompared to 36,000 fps for re-entry to Earth from a lunar mission.

Moreover, the Venusian atmosphere nay be denser than Earth's. The combination of high re-entry speed, plus a lenser atmosphere will bring up severe e-entry heating and shaping problems. "We may have to go to more slender hapes for Venusian re-entry," Pearson uggested, observing that this is a technique opposite to that used with *Apollo*.

• **Materials**—Systems for planetary e-entry are reflected in materials and tructures needs. A big problem is designing ablators for such re-entry, George Deutsch, NASA's chief of the naterials research program, told M/R. He took pains to point out that the solution is far from evident.

He said NASA is putting increased emphasis on materials with long life. "We were concerned with *Apollo* with a lifetime of two weeks," he said, "but now with manned orbiting stations, we will need minimum lifetimes of materials of nearly a year."

Deutsch is calling for materials that will yield component life of 10,000 to 25,000 hours. "This is one of the big trends and introduces an entirely new category of problems."

"Time-dependent life," says Deutsch, "will be our criterion for materials." Most major systems today are designed for indefinitely long life—bridges, roads, houses, railroad cars and such. In a hostile atmosphere, however, such a philosophy costs too much in time and money. Deutsch admits this is not a new approach, but he says it is one that will receive more attention in NASA's space systems.

He explains that NASA will look harder at lightweight structures such as foils, honeycombs and sandwiches. Observing that a remarkable degree of stiffness can be obtained by an appropriate design using these techniques, Deutsch said there are still many problems: working out fabrication methods, determining the properties of these structures, joining them and learning their behavior in a space environment.

Within the next four or five years, the 10-year-old technology of metal dispersions is expected to expand and play a large number of major roles in missile and spacecraft structures. Classically, the useful strength of a metal disappears at about 60% of its melting point. Alloying helps raise this limit, but dispersions can keep a metal matrix useful as a structure when operating as high as 90% of its melting point.

Aluminum dispersions and thoria dispersed nickel are two available commercial products, marketed by the Aluminum Co. of America. Experimental dispersions include the refractory metals and also a stainless steel dispersion which "looks good as high as 1,800°F," according to Deutsch. Stainless itself usually reaches its useful limit at 1,300 to 1,350°F.

Polymers are coming into use for space work much more rapidly than some NASA materials experts had foreseen. The outlook is for polymers able to withstand high temperature for extended periods, that is, above 400° to 500°F.

Materials systems also are being pushed as answers to problems that have no solution in terms of a single material. The grandfather of a materials system is, of course, reinforced concrete, where the metal strands take the tension loads while the concrete takes the compressive. A typical space materials system would be a sandwich of many layers of materials, each serving one or more functions.

The outer layer of a spacecraft might be for thermal control and serve as a container for a second layer or cellular structure. The cellular structure, in turn, could be an insulator, an absorber of micrometeorites and a sealant for punctures. In this manner, a spacecraft "skin" could be designed.

Nothing new is claimed for this approach except that it is now recognized as a methodology which will be "a way of life" for future space designs. ■

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VEHICLE ELECTRONICS

The success of the Manned Lunar Program requires the development of advanced telemetry and instrumentation systems to provide accurate development information during ground and flight tests of the Saturn S-IVB. The success of S-IVB systems depends on innovations in packaging techniques to insure reliable operation during extensive space flight.

Douglas is seeking vehicle electronics specialists with experience in field station test, circuit design, electronic packaging, or other related areas who can meet the Saturn S-IVB challenge in initial design, hardware design and development tests. Send your resume to Mr. W. S. Ames, Douglas Missile and Space Systems Division, 3000 Ocean Park Boulevard, Santa Monica, California.

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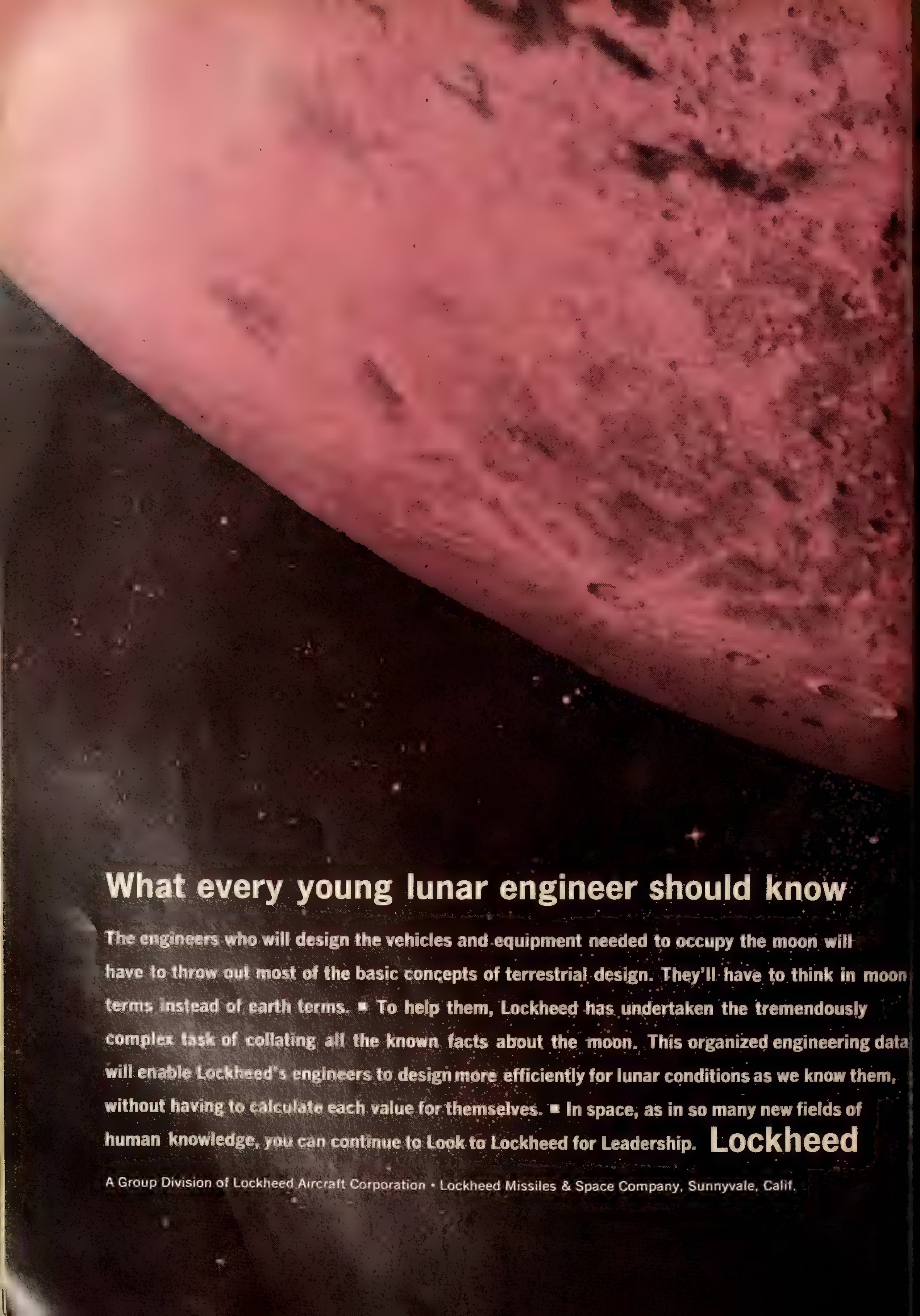

What every young lunar engineer should know

The engineers who will design the vehicles and equipment needed to occupy the moon will have to throw out most of the basic concepts of terrestrial design. They'll have to think in moon terms instead of earth terms. ■ To help them, Lockheed has undertaken the tremendously complex task of collating all the known facts about the moon. This organized engineering data will enable Lockheed's engineers to design more efficiently for lunar conditions as we know them, without having to calculate each value for themselves. ■ In space, as in so many new fields of human knowledge, you can continue to Look to Lockheed for Leadership. **Lockheed**

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Propulsion Research Aim At Developing New Fuel Combination

Thrust goal set at 20-30 million lbs. for large engine fluorine pushed as next major propellant for post-Centau upper stages; big solids facing difficult budget battle

A SERIES OF NEW research programs and shifts in emphasis on propellant combinations characterize NASA's propulsion planning outside the *Apollo* program.

Some of the chief developments include:

—In the large liquid engine field, the major tendency is toward high-pressure powerplants mainly employing liquid hydrogen/LOX systems.

—A new experimental engine program modeled after the Air Force engine improvement approach is being instigated. First in the program is the J-2 liquid hydrogen unit.

—A sustained effort will be made to acquire the basic engineering knowledge needed to design screech-free engines. Plans call for long-range funding.

—Large solids are receiving more attention, but face tough going in future budget battles.

—Fluorine is being actively pushed as the next major engine development program for high-energy upper stages beyond the *Centaur* level.

• **Propulsion research**—NASA is funding about 150 separate programs covering the various component areas in large liquid engines for *Nova*-type boosters and the smaller spacecraft propulsion units needed for space maneuvering.

All types and kinds of concepts are being studied—multiple-combustion chambered units, toroidal chambers, plug nozzles and simplified approaches such as the Advanced Liquid Propulsion System (ALPS) under investigation at Jet Propulsion Laboratory.

In the large engine area, NASA has set 20 to 30 million lbs. of thrust as a basis for planning. There is strong emphasis on end-product thinking. Component research goes through a cycling process—from theory through some experimentation and then into currently proposed systems design. This cycle keeps repeating. Thus NASA has a good grip on the technology in anticipation of an eventual go-ahead on a *Nova* program—regardless of when the decision is made.

John L. Sloop, Chief of Propulsion and Power Generation in the Office of Advanced Research and Technology, says the areas of interest range from liquids through hybrids to solids, and there is no special effort to push particular systems. Later mission studies generate emphasis.

In the large-thrust engine category, the trend is toward high-pressure systems, and stress is laid on the liquid hydrogen/LOX combination. Kerosene is still a contender but, at the moment, its proponents are in the minority.

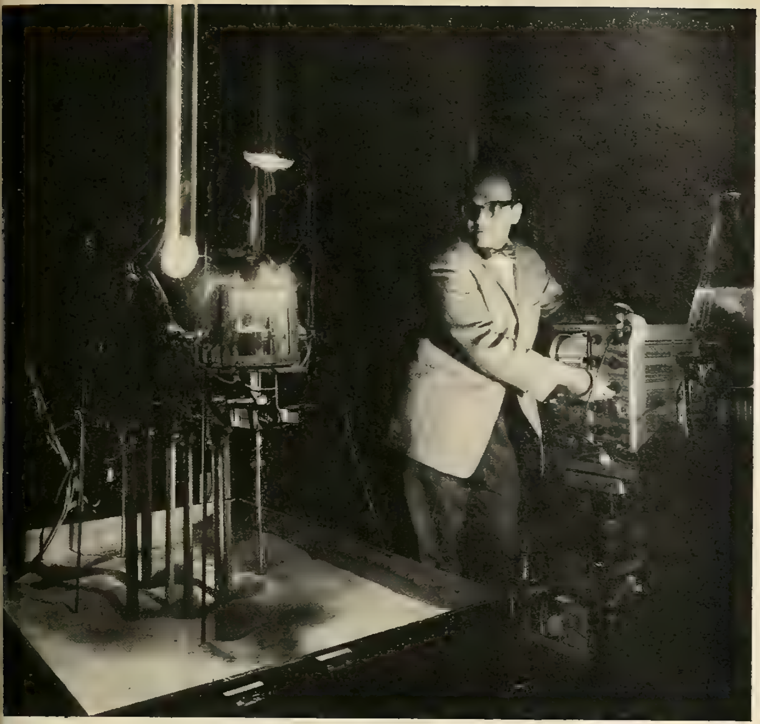
Another major movement within NASA is toward the experimental engine program—where a currently mission-oriented engine design is coupled to an improvement program. This is a new philosophy at the space agency, although the Air Force has been using it for some time. A prime example of the usefulness of the approach is th X-1 engine improvement project. Th agency will fund separate program based on current engines without di turbing the original engine program.

As various concepts begin to tak shape in the light of the current *Nov* launch vehicle studies, a certain amoun of direction is given to research pro grams. For instance, as flow rates ar defined, component investigation achieve a greater definition.

NASA has pump work sprea across the country—almost 33% of th cost of any new liquid engine develop ment program goes for pumps and as sociated equipment. The general tone c the research here is now keyed to th limitations of current pump designs an configurations. Past experience ha shown that the pump art depends con pletely upon the particular engine; onl certain generalities can be made fron system to system.

• **Hotter engines**—There is grow ing interest in high-energy space-stora ble propulsion systems—most of all, a present, in the OF_2/diborane combina tion. Feasibility of this partnership i yet to be established by NASA, but th consensus is that it looks good.

Almost all of the advanced system under study have one common charac teristic—combustion temperatures ar rising. Some high-energy storables ar well into the 7,000°F range. This prob lem also affects nozzle innovations.



BOVE: Zero-gravity in-
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ent of multi-million-
und-thrust engines.

Plug nozzle performance to date dicates that this configuration is an proach to the ideal booster nozzle. t the maximum heat transfer rate th the plug nozzle occurs in the throat gion—its maximum surface area.

Regenerative cooling has been the imary method in most operational uid engines. The liquid hydrogen/ X engine will also depend on this stem, since hydrogen has a high heat pacity and does not decompose.

As engine pressures increase and h-energy fuels move into space- gine use, regenerative cooling will e way to either ablative or radiative thods. Here materials pose a major oblem, and there is an extensive evaluation effort at Lewis and other centers.

Even evaluation methods are suspect—one NASA official calls it a "black art." There are programs aimed at establishing fair means of materials comparisons for evaluation programs.

NASA propulsion experts are pushing for better instrumentation. There is a unanimous feeling that a little investment in this area will provide high returns in the near future—and funding is being projected. The general requirements are smaller size, better response and longer life.

More complex instrumentation concepts are under study contract. The rocket engine analyzer and decision instrument (READI) program at Sperry is a prime example. This is aimed at malfunction detection, but with something more than a mere abort solution. The result might be immediate corrective measures—changing mixture ratios or chamber pressure—to alleviate the cause of the malfunction and continue the flight.

The greatest single obstacle to development of new and improved rocket engines—large or small—lies in certain peculiar sounds emitted by powerplants in operation.

Commonly called screech, screaming, squealing or buzzing, the sounds are all manifestations of combustion instability—one of the least understood characteristics of a rocket engine.

The key to the lack of knowledge and understanding of the phenomenon is in the very complexity of the combustion process within the engine. A highly involved series of processes occur from the moment the propellants are injected into the combustion chamber to the instant the flaming gases reach beyond the nozzle area.

Each of these processes, such as vaporization, diffusion and combustion, takes place in its own special way. The speed of each depends on such factors as the mixture ratio, and the pressure, temperature and velocity of the gases in the chamber.

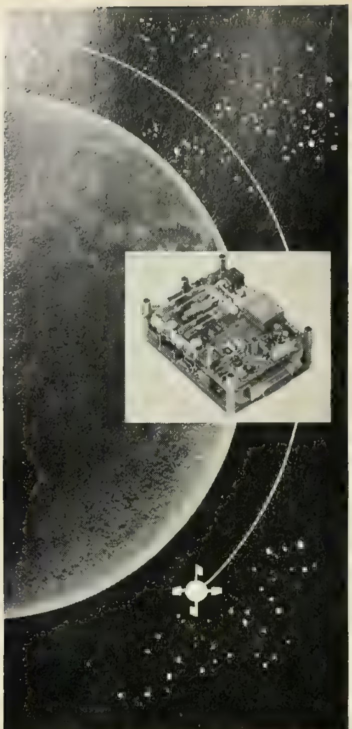
There are two general types of combustion instability—low-frequency, or "chugging," and high-frequency, or "screaming." The first has its origins in the coupling of combustor pressure variations with those in the feed system. This instability mode has been successfully avoided through injector design—although it is not completely understood.

High-frequency instability still is largely a mystery which has to be solved in almost every engine by trial and error. Here one or more acoustic modes of the combustor may be excited to large amplitudes.

- **Engine destruction**—These waves interact with the combustion processes to cause large variations in local heat release rates. This usually results in wall failures—or the vibration may induce structural failures. A great deal is known about the effect of instability.

Destructive high-frequency oscillations have been met and conquered in many currently operating engines of all types, but the process has been and continues to be empirical. The main need is for a precise theoretical model of the entire combustion process that will account for these characteristics.

A great deal of theoretical and experimental work is in progress, and this has been under way for years. NASA is now establishing a sustained effort in the general problem area. The plan is to maintain a long-range but



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modest program constantly attacking the entire field of instability.

The Lewis Research Center will manage the program, which will involve both in-house and contracted research together with accumulation of all known data on the subject. The principal aim is to lay a sound engineering basis for the first screech-free engine.

- **Fluorine technology**—NASA has been dabbling in F_2 technology for almost ten years—F_2 was tested with LOX in the *Vanguard* engine at Lewis in 1956. The area is receiving increasing attention now that the state of the art in liquid technology is penetrating deeply into liquid hydrogen/LOX.

One major advantage in pure F/H systems is that the combustion curve rises fast—there is less time for pressure to influence stability. The fluorine work to date indicates that the more energetic the system, the less danger there is of combustion instability.

NASA propulsion experts, both at Headquarters and Lewis, do not expect any major research problems in the fluorine-oriented programs now under way. Heat transfer work and investigations into materials compatibility are still in progress. The general rule in fluorine systems is to avoid plastics—although certain Teflon parts seem to perform adequately.

In one program at Pratt & Whitney, the RL-10 hydrogen-LOX engine is being used as a test bed for fluorine systems—starting with LOX-rich mixture of fluorine (FLOX) and moving towar pure F_2.

Preliminary indications are tha non-plastic substitutes must be used i the pumps and seals. Subscale work ha revealed that coaxial injection system work as well with F_2 as with hydrogen oxygen propulsion schemes.

Another program with the Rocke dyne Division of North American Avia tion covers mating FLOX with th H-1 engine system. Here the *Atlas* pro pulsion system is being investigated fo FLOX compatibility. The particula emphasis is on the sustainer, vernie and gas generator subsystems, and it primarily a materials compatibility jo Should all parts of this program wor as planned, the second phase of th project might go all the way to a tes flight. General Dynamics/Astronautic is working with 30% FLOX on the oxi dizer side of the *Atlas* vehicle system— checking tankage, valves, filling, boil off, venting and shut-down processes.

The approach—that of goin through current engines and launch ve hicle systems—is far less costly tha designing straight through to a complet F_2—O_2 operation engine and then to vehicle.

(*Continued on p. 67*)

Fluorine—The Next Major Propellant

NASA PROPULSION experts have gathered an enormous amount of successful operating time and experience with highly reactive F_2 by keeping their systems stringently clean.

The primary cause of failures in fluorine systems is contamination—not the materials selection or even the configuration of system components. In this sense, contaminants are any foreign materials, organic or inorganic, existing within a fluorine system and not fully fluorinated.

The second cause of failure is leaks. If the fluorine escapes and comes in contact with contaminated surfaces, the result is usually autoignition.

Thus, in the design of a reliable fluorine system, the greatest emphasis is on cleanliness, thorough passivation, leakproofing and the avoidance of irregularities in the flow passages such as crevices, lap joints, weld slag and rough or oxidized surfaces.

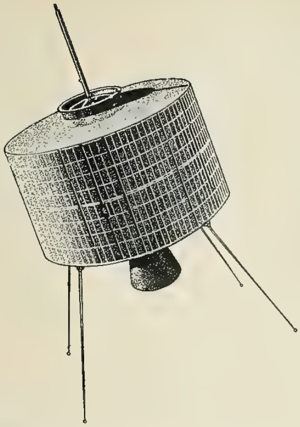
The next large problem area is the handling of fluorine exhaust gases. A 30,000-lb.-thrust engine operated with F_2 and H_2 might generate 50 lb. sec. of hydrogen fluoride. These gases may be released to the atmosphere if the firing is in a remote area.

If this approach is ruled out, then the exhaust gases can be water scrubbed and the contaminated water treated with lime slurry to convert the acid to the more amenable calcium fluoride. This is an expensive approach.

A cheaper method might use a simple "swimming pool" scrubbing operation where the exhaust gases blast directly into a contained body of water.

Unlike LOX, F_2 should not be directly vented to the atmosphere in any area of large usage such as test stands and launch sites. One method of eliminating this hazard would be to react the excess F_2 with charcoal—producing the relatively inert carbon tetrafluoride. There are other methods.

In any event, large-scale use of this reactive element will call for alterations of facilities at both test and launch sites.



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the shapes
of things
to come
are
formed
every day**

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(*Continued from p. 64*)

As the FLOX programs progress, ASA will be looking at the overall easibility, cost effectiveness and comonent problem areas. The cost aspect lone in a straight fluorine development rogram is heavy—in terms of the speial facilities needed (see box). By determining the most effective LOX-fluoine mixture, one gets a boost in specific mpulse at a moderate cost. Cost is the ey, since a FLOX-*Atlas* will have only 12 to 18 second increase in I_{sp}.

The complexity of fluorine technolgy extends beyond its use as an element. Ozone difluoride, if added to LOX minute amounts, will make the oxiizer completely hypergolic to H_2. This spect is under investigation at Stanord Research Institute.

- **Solid's rise**—It is a historical fact hat NASA has all but ignored the poential of solid motors as a major source f booster power. This outlook has hanged drastically in the last 12 onths. The space agency had been ontent to let the military develop solid otors—to the point that the present ilitary rocket arsenal is overwhelmgly solid.

Now there are 30 contracts coverg solid systems from motor support to gistics and economics. These include e general areas of missions and sysems, and systems support.

Most work in solids is funded rough the Air Force in the Large olids Demonstration program. There complete coordination between NASA d the Air Force in this endeavor—d the minimum-cost project was saved om the Defense Dept. economy axe rough the intervention of NASA Adinistrator James E. Webb.

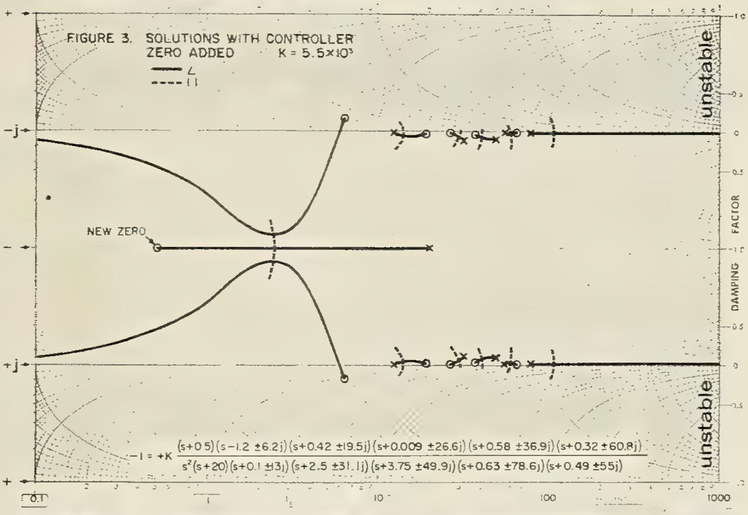
The first phase of this demonstraon program involves the constructing d static-firing of 3 million-lb.-thrust, alf-length, 260-in.-dia. solid motors. he second phase will move to fullngth units, but the facilities for these e under construction right now as part the industry support for phase one.

If things go perfectly in the demonration program—and the consensus is at the problems will be relatively minor—the U.S. will have a demonstrated pability in multimillion-lb.-thrust solid oster motors by early 1965. This about the time when the first major *ova* booster decisions are expected.

Solids still face several major fundg hurdles in the follow-on to the curnt demonstration program. And some the *Nova* studies are moving away om solids—at least from the standoint of economics.

- **Electrical and nuclear**—For long rm, great-distance space missions—oth manned and unmanned—the elecical engine has long been recognized the only economical source of propul-

esiac



$$-1=+K\frac{(s-1.2\pm 6.2j)(s+0.42\pm 19.5j)(s+0.009\pm 26.6j)(s+0.58\pm 36.9j)(s+0.32\pm 60.8j)}{s^2(s+20)(s+0.1\pm 13j)(s+2.5\pm 31.1j)(s+3.75\pm 49.9j)(s+0.63\pm 78.6j)(s+0.49\pm 55j)}$$

Analysis of the Structural Resonances of a Missile

Illustrated above is an ESIAC root-locus analysis of the characteristic equation of a closed loop system. This problem was submitted by an ESIAC user in the missile field and is discussed in detail in a current series of bulletins dealing with typical applications of the ESIAC® Algebraic Computer. Note that the problem contains 23 singularities. Shaded areas on the graph sheet represent the unstable portion of the log s plane. K is the varied parameter.

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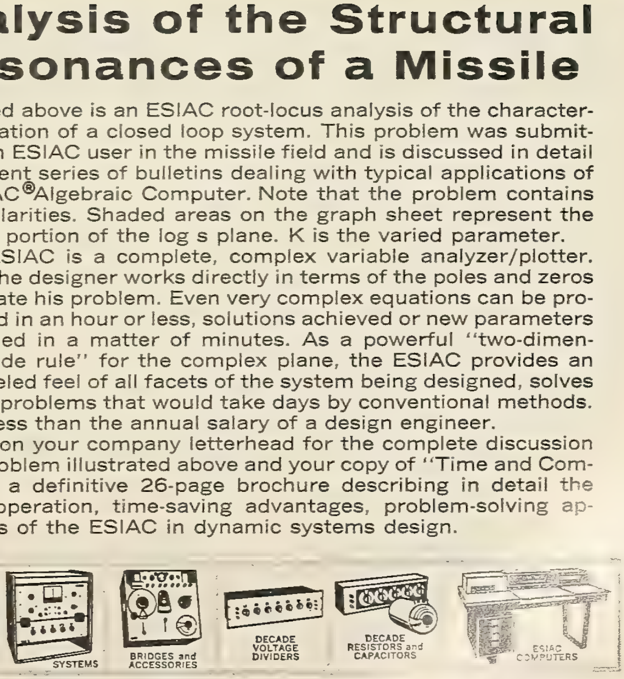

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Putting the lid on a big one

This top head is shown being lowered onto one of the three 39-foot spherical simulation chambers at the recently completed Space Simulation Test Facilities at the General Electric Space Technology Center, Valley Forge, Pennsylvania. CryoVac, a sub-contractor to the F. J. Stokes Corporation, Philadelphia, designed and installed the thermal shrouds, heat sinks—like the one suspended under the lid—cryopumps and associated cryogenic equipment including controls for the facilities. ■ This isn't the first lid we've helped put on a space simulation chamber and it certainly won't be the last. We helped place quite a few. In fact, the cryogenic equipment in many of the simulators now in existence or under construction has been designed and built by CryoVac. ■ CryoVac's experience goes even beyond cryogenic systems however, it includes responsibility for the design, fabrication and erection on many programs. Why not take advantage of this wealth of experience—write today.

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sion. There are instances where electrical units are superior to the ultimate —the nuclear rocket fusion engine.

Current work in the electrical area is divided into two sections—the engines and their power sources. Engine design and testing is far beyond the present status of advanced power systems. Single ion engines have been fired in various industrial and government labs around the country.

In the next calendar year, the Lewis Research Center expects to be static-testing arrays of ion engines. Systems of three small units have already been fired. Larger arrays or clustering are in the works.

On the single engine side, Lewis experts are planning a series of scaled-up ion units ultimately reaching one meter in diameter. The single engine has a higher reliability factor than clusters of smaller ones—and the large units can again be clustered if desired. Funding will remain at the Fiscal 1963 level.

The potential of electrical propulsion systems has been presented many times at various technical meetings, but one example will serve to illustrate the economics of the approach.

The analysis concerns a 500-day, 8-man roundtrip to Mars. The electrical vehicle with propellant, crew and crew supplies, Mars exploration vehicle, electrical powerplant and return payload would weigh 450,000 lbs.

Only two current state-of-the-art *Saturn V* vehicles would be needed to boost the component parts in an Earth-launch orbit. If the entire mission was planned for chemical propulsion methods, there would be a need for 40 *Saturn V* launches to place spacecraft components in an Earth-launch orbit.

Electrical engines must have an on-board power supply. This remains the major problem. One major approach is the nuclear-fission turboelectric system.

In the turboelectric scheme, a heat transfer fluid—actually a liquid metal—would be passed through the nuclear reactor, picking up energy in the form of heat. This fluid would become radioactive and would, in turn, heat a secondary or working fluid in another heat exchanger. The working fluid would not be radioactive.

The working fluid is vaporized in the heat transfer procedure. This high-temperature, high-pressure vapor expands through a turbine which produces rotary motion. A converter generates electrical energy from this motion. The working fluid is then condensed in a radiator and recirculated.

The problems associated with such a system are obvious. Pumps, seals, high-temperature materials, liquid metals and radioactivity all combine to present a major designing task.

In addition, the system must function for at least a year without repair. And it will operate in the vacuum of space—reducing the heat transfer approaches to only radiation. But this seems to be the most promising approach to long-term space power. NASA is pursuing both in-house and industria programs. General Electric will soo have a large and complex turbine tes facility in full operation. Here liqui metals will be run through entire loop while various concepts and designs i the component area will be tested.

Even though electrical engines hav yet to be sent on operational test flights far more advanced propulsion method are under study. Scientists at Lewi have completed a theoretical study int a radioisotope electrostatic propulsio system. Basic work so far has show no reason to assume the method will no work. One NASA expert flatly predict this will be the only practical approac to an electric-powered Martian probe.

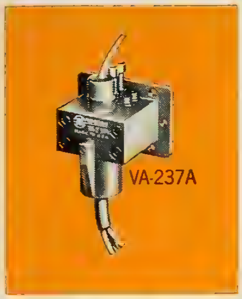
● **Direct conversion**—In this system, the powerplant is actually a atomic battery in which the nuclea energy of radioisotopes would be converted directly into electricity. Gettin the radioisotopes themselves has turne out to be less of a problem than wa anticipated. The NASA studies have settled on polonium 210, although cerium 144 would serve just as well with a littl more work.

Detailed system studies have show specific powerplant weights of 0.5 l per kilowatt can be achieved. This is considerable reduction over any othe electrical generation approach. It is bu the first tentative step towards such system, and the problems may seem fo midable, but other programs closer t fruition will provide a great deal in th way of engineering knowledge and materials.

The next major advanced propu sion concept involves the creation an harnessing of nuclear fusion. A co siderable effort is being supported b the Atomic Energy Commission i Project Sherwood, with the aim o achieving a controlled thermonucle reaction. Several fusion reactions a under investigation, but NASA seems t be interested in only one—deuteriu helium-3. The main reason is that th reaction results in charged particles wi the possibility of magnetic containmen

Creation of such a reaction is complex problem in itself, but the co tainment and use of it in a space prop sion system is equally tough. NASA a vanced propulsion experts now say th superconductive magnets are the key thermonuclear space propulsion.

Further, since the thermonucle



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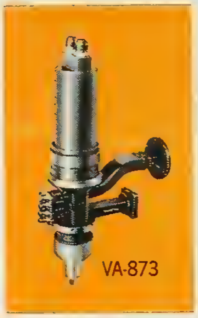

106 kW CW AT X-BAND! FROM VARIAN

Varian now offers the VA-873 SBK* amplifier klystron, providing the world's highest CW power at X-band. More than 106 kilowatts was obtained from a single tube during extensive evaluation tests in the laboratory. Production tubes will be conservatively rated at 50 kW CW. *Single Beam Klystron

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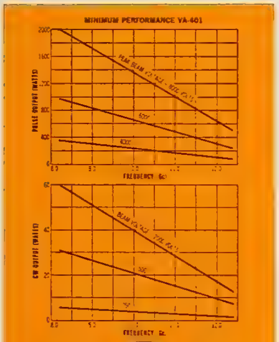

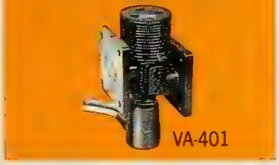

LIGHTWEIGHT X-BAND TUBE OPERATES PULSE OR CW . . . . NEW FROM VARIAN

Varian's new VA-401 klystron can operate either as a pulse or CW amplifier at any fixed frequency selected between 8.2 and 12.4 Gc. Exceptional design permits this tube to be operated at various power levels by using the appropriate beam voltage. ■ This electrostatically-focused three-cavity tube will deliver at least 500 watts in pulse service and 10 watts CW at the high-frequency end of the operating range. As shown in the graphs above, the output at the low-frequency end of the range is several times greater. This tube is an excellent choice for airborne CW radar, doppler navigation, multichannel parametric amplifier pumping, or synchrodyne systems. Typical gain, 30 db. Weight, 13 ozs. Write for more information.

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State-of-the-art microwave tubes from VARIAN associates

Varian's continuing efforts in research and development in microwave tubes have produced components now in use in such NASA programs as the MARINER and SURVEYOR projects, the Mercury Seven series, and many others. Look to Varian when design requirements demand state-of-art microwave tubes.

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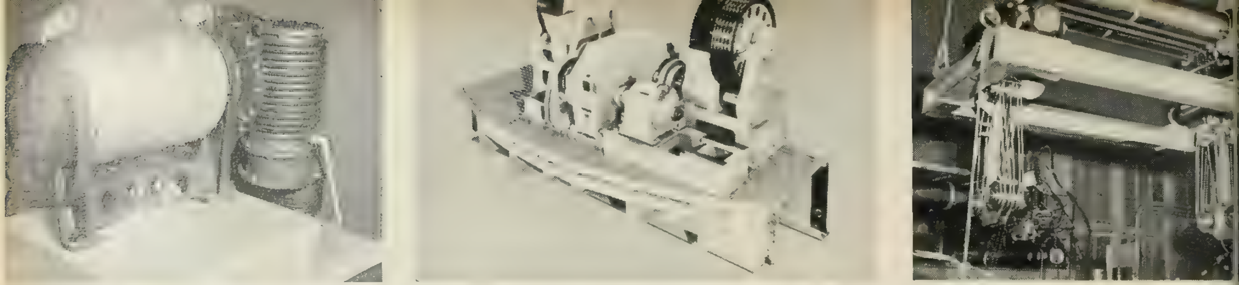
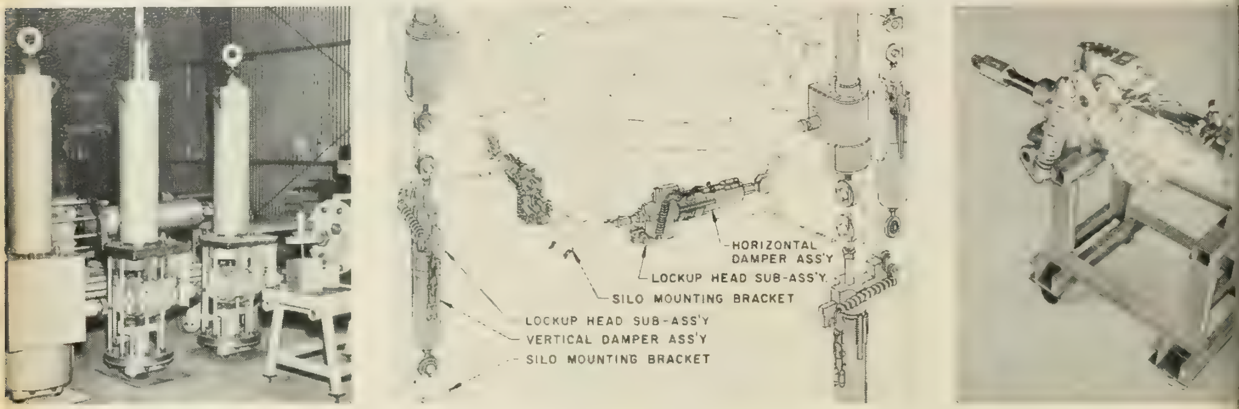
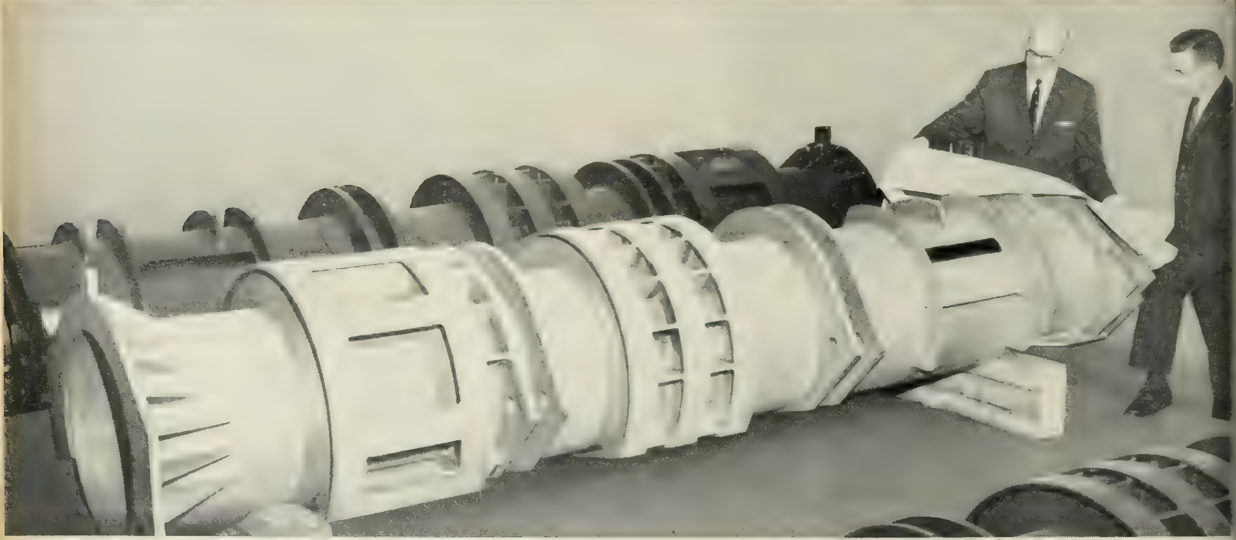


HOISTS—Western supplies these heavy duty hoists for (1) Nike Zeus (2) Atlas and (3) Minuteman missiles.



SHOCK ISOLATION—Vertical and Horizontal damper assemblies of Western's Shock Isolation System for the Titan II.



SPRING CAN ASSEMBLIES—Built by Western as a precision component in the Minuteman missile silo system.

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For example: Hoists for the Atlas, Minuteman and Nike Zeus. Damper assemblies for the Titan II's in-silo shock isolation system. Spring can assemblies for the Minuteman's silo system.

These are just samples of Western's capabilities in grour handling, missile positioning and shock isolation equipmei Don't they suggest that you call on our "missile muscle men as a reliable source for this type of gear? Write or call f prompt attention to your newest problems. WESTERN GEA CORPORATION, Precision Products Division, P.O. Box 19 Lynwood, Calif. Cable address WESTGEAR, Lynwood, Cal

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approach eliminates any interim stages n providing propulsive power, it may vell be the first major application of nuclear energy to rockets. Extensive, deailed calculations have been performed by both NASA and certain propulsion irms independently of each other. The esults agreed substantially, and there is now a great deal more interest in the hermonuclear approach.

Since the crux of the concept is the development and use of superconducive magnets, a strong research effort s being pursued at Lewis.

High-field magnets and magnetic reearch at Lewis covers the production of high-strength magnetic fields and heir use in fundamental research.

The concept of low-voltage/high-urrent design of electromagnets led to he procurement of a homopolar generator as a power supply for these magnets. This device uses liquid metal brushes to collect the charge generated by the rotation of a steel cylinder in a magnetic field produced by a conventional motor generator.

The machine has been used to power three high-field electromagnets—wo water-cooled and one cryogenically cooled. The water-cooled devices have been useful in research in superconducting alloys and intermetallic compounds. The materials of most interest have been Nb-Zr alloys and the intermetallic compound Nb_3Sn. Other research areas nclude the magneto-resistance of pure metals and crystals, the Hall effect, the Zeeman effect, the nuclear-magnetic esonance and other resonance effects.

A large magnet under construction at Lewis will provide fields up to 200 kilogauss for several minutes. Plans are being formulated for a magnetic mirror machine using 36 coils. This should provide a central field of 100 kilogauss with end mirrors of 200 kilogauss. The device will be used in fundamental tudies of heating and containment.

In the superconductive area alone, a wide variety of research problems exist. One of these is the "training effect" —where a superconducting coil "learns" o build higher and higher fields. Another is the fact that the maximum curent a given superconducting wire will carry decreases with increasing length.

A host of metallurgical problems are associated with superconductivity; he simple act of constructing such magnets is a tedious, time-consuming job—one flaw and the entire magnet can go normal.

Both propulsion systems and the magnetic field work pose serious problems which must be solved before any eal feasibility can be demonstrated. Yet these approaches represent the only ealistic approach to the economical exploration of space beyond 1970. ■

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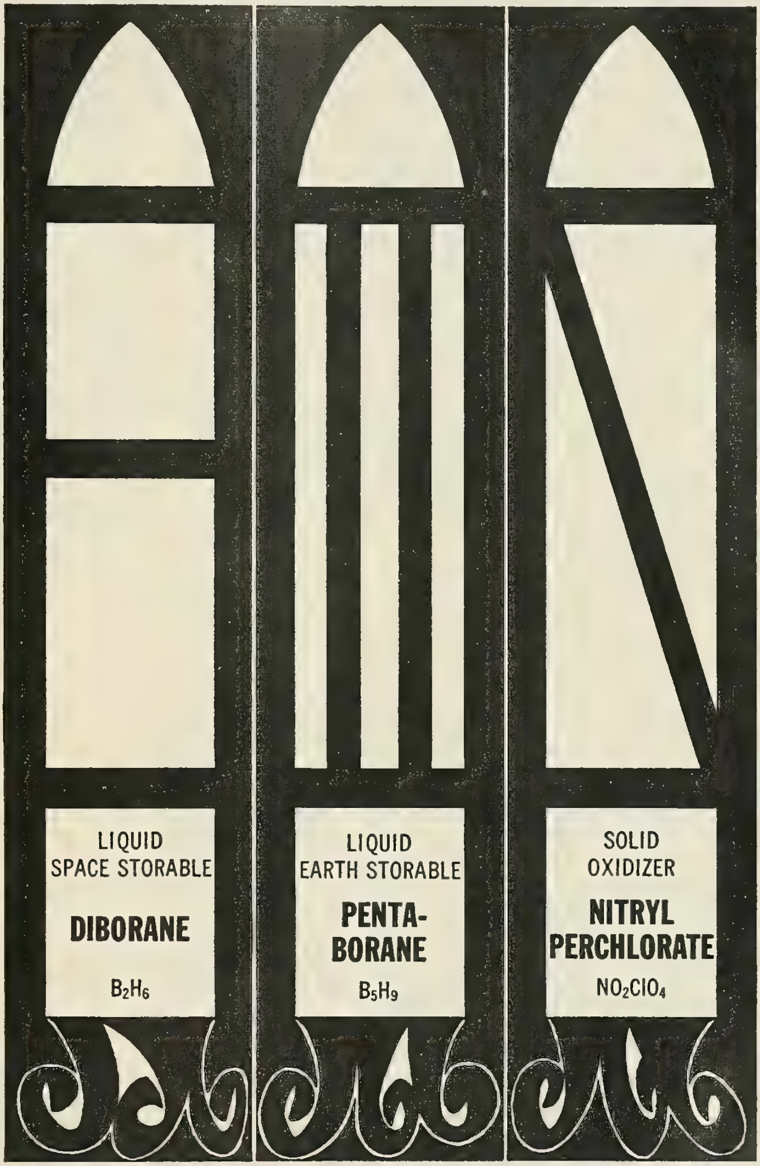

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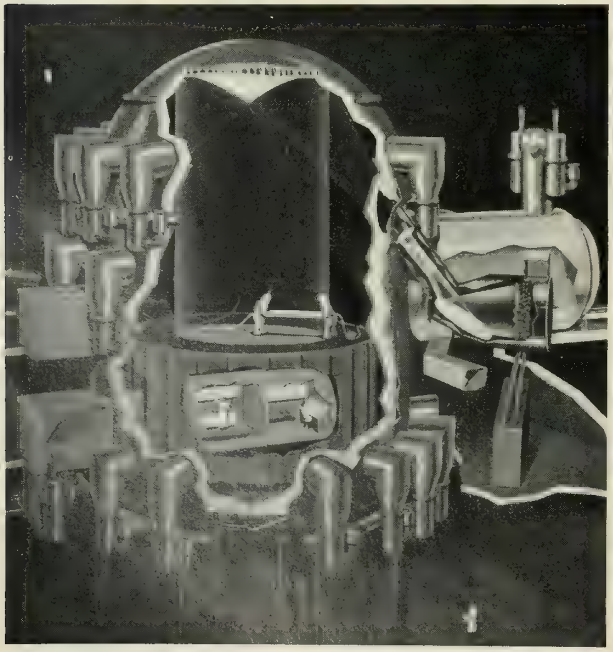
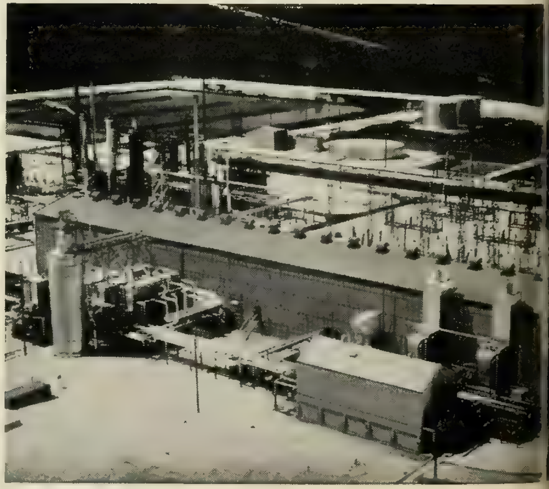


LUNAR ENVIRONMENTAL RESEARCH FACILITY—U.S. ARMY CORPS OF ENGINEERS: *Lummus performed the conceptual engineering for this simulator which established the engineering feasibility to provide for vacuums up to 1×10^{-8} torr, temperatures as low as −423°F, and solar radiation twice the intensity of the noonday sun—up to 130 watts/sq. ft.*



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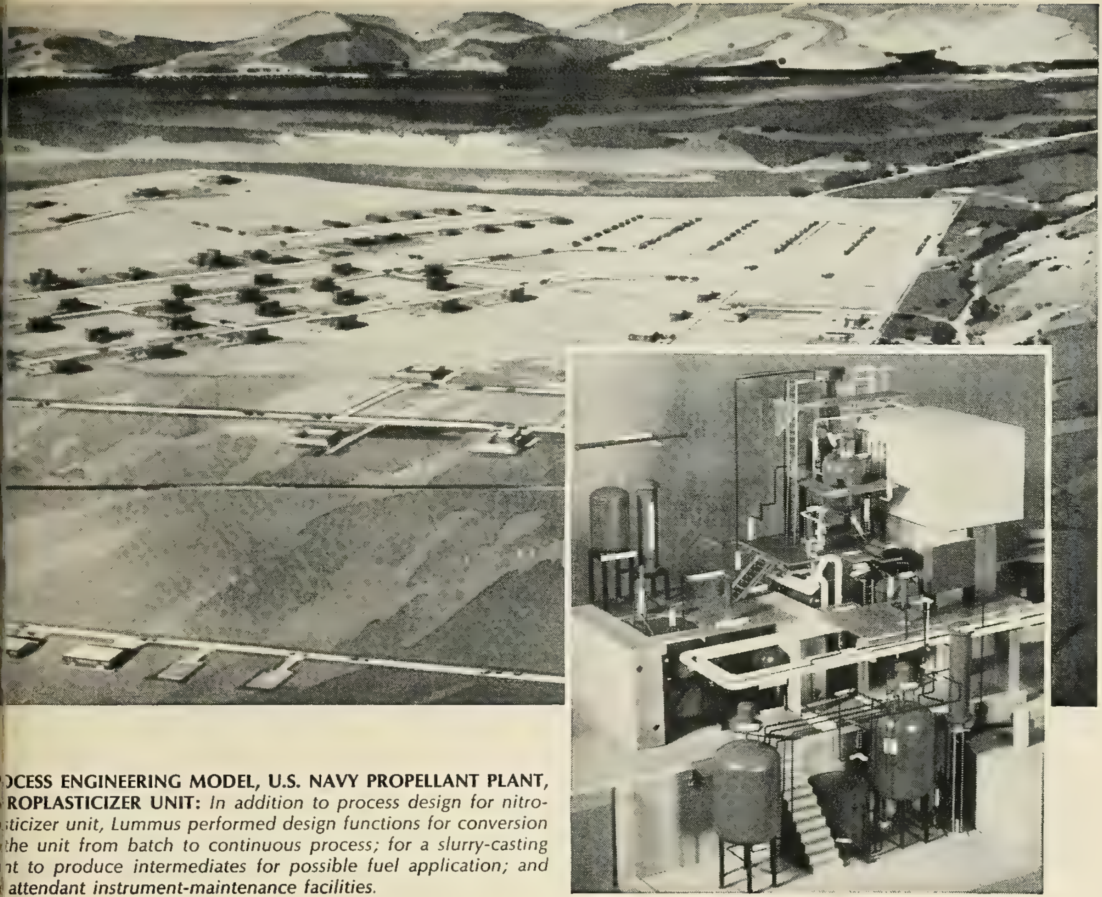

OCESS ENGINEERING MODEL, U.S. NAVY PROPELLANT PLANT, ROPLASTICIZER UNIT: *In addition to process design for nitro-sticizer unit, Lummus performed design functions for conversion the unit from batch to continuous process; for a slurry-casting nt to produce intermediates for possible fuel application; and attendant instrument-maintenance facilities.*

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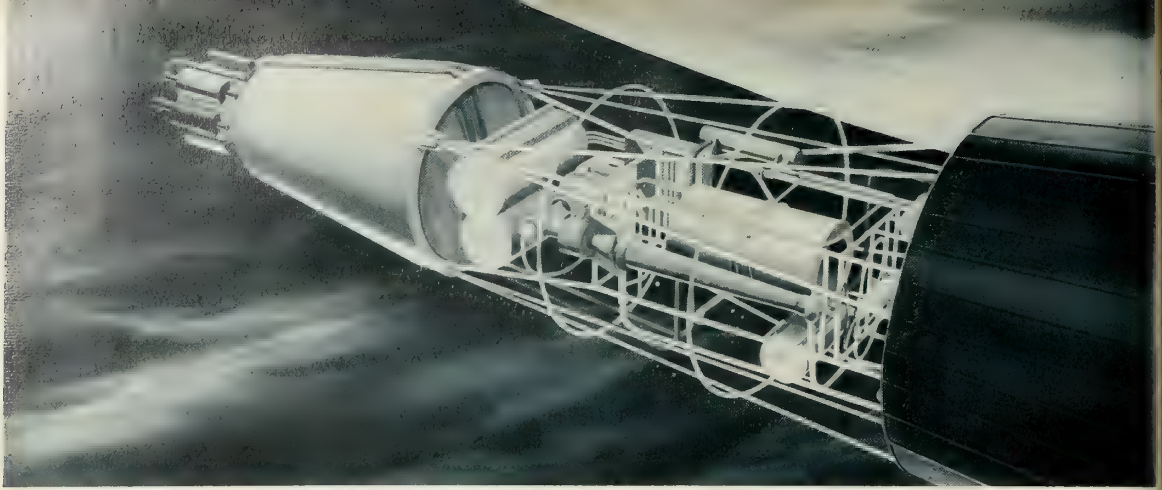


NASA'S SNAP-8 nuclear-electric power-generating system shown in artist's concept during a Mars fly-by mission. Designed by Aerojet-General Corp., SNAP-8 is expected to provide 35 kw for more than 13 months of continuous space operation.

Nuclear Systems Development To Be Dominated by Electric Engines

NUCLEAR SYSTEMS for NASA programs are expected to grow most spectacularly in the electric engine field, particularly for relatively long-duration missions.

The nuclear rocket, on the other hand, limited at best to 1,000-seconds specific impulse and probably closer to 700 seconds, will have difficulty in long-duration missions, but should be competitive on a payload basis for the shorter missions of around 250 days.

The technical problems raised by both the electric systems and nuclear rockets are difficult, but the electric systems include the greater possibility for growth as well as the greater number of feasible concepts.

- **State of the art**—The technology for small electric-propulsion thrustor systems, 1 kw or less, is being well defined, thus allowing for early application of this technology for attitude control and station keeping of satellites. Here the power supply would be solar energy.

In the field of large-thrustor electric engines for prime propulsion, where nuclear energy is the power source, a systematic building block technique is being used to attain the high power level in a most efficient manner. A variety of engine concepts are being investigated, since it is too early to predict which of these concepts will be amenable to scaling and to providing high performance and reliability for long-duration missions.

The current thrustor modular technology is still in the kilowatt range, with complex and difficult problems to overcome for scaling and attaining long life, minimum size and high efficiency. The problems, however, do not appear insurmountable, and with the proper effort, electric thrustors in the hundreds-of-kilowatt or even megawatt power level should become available in the early 1970's. This is within a frame of time when it is hoped that large, lightweight power systems will become available to make electric propulsion competitive.

The NASA electric rocket engine program is directed at converting electric power into thrust. The need for electric propulsion systems on space vehicles is dictated by the limited growth potential of chemical rockets.

- **Need for electric engines**—Many studies have shown that electric propulsion could have a factor of several orders advantage in the payload-to-initial-vehicle-weight ratio over conventional rocket systems for many space missions. This large payload-to-weight ratio advantage is due to the use of higher-velocity propellants. Also, the major deficiency of chemical rockets is the large rate of propellant consumption required to obtain adequate thrust for delivery of large payloads into space. Thus the chemical rocket will require enormous amounts of propellants for long-duration missions in space.

Electric propulsion systems could provide economical propellant consumption and power and low thrust levels, from a fraction of a pound to hundreds of pounds. This thrust range is adequate for space propulsion, since there is no friction to overcome in space. The low thrust of electric-rocket engines will limit their use to vehicles boosted into an orbit by other means. Thus, an electrically propelled spacecraft must be launched into a low-drag satellite orbit from Earth by chemical rockets before its propulsion system can be advantageously used for space travel.

The low fuel consumption of the electric rocket is reflected by its high specific-impulse range (800 to 30,000 econds). Compared with a chemical ocket with a specific impulse of several undred seconds, the potential advan-ages of an electric propulsion system or long-duration missions can easily e seen.

- **Applications**—Potential mission pplications for electric rocket engines nclude position control (attitude con-ol and station keeping) of spacecraft nd primary propulsion of unmanned nd manned spacecraft, I. R. Schwartz, ASA's chief of electric thrust systems, old MISSILES AND ROCKETS. These ap-lications cover a range of engine sizes om 200 watts (several millipounds of rust) required for position control of pacecraft to the very large engines up many megawatts of power (hundreds f pounds of thrust) required for prime ropulsion to perform the manned mis-ons.

Space science or unmanned explora-on probes may require electric engines the intermediate power-level range of undreds of kilowatts, depending upon e size of the spacecraft and the allow-ble mission time.

A comparison can be drawn be-ween the performance capability of mall chemical systems and that of e small electric system for position ontrol of satellites. A 550-lb. satellite, or instance, would have to be charged ith approximately 85 to 106 lbs. of hemical propellant for a three-year peration as compared to 26 to 65 lbs. equired for an electrically powered peration—saving 40 to 80 lbs.

In estimates projected to large satellites, such as a manned orbital research laboratory, the electric propulsion position control systems could provide even greater advantages.

A typical ion system suggested for attitude control and station-keeping contains 11 thrustors grouped into four pods. Each pod contains 0.5-millipound thrustors for attitude control. Three of the four pods also contain 1.5-millipound engines for station keeping. A recent suggestion calls for combining the small ion engine station keeping system with a gravity gradient attitude control system, thus resulting in a nearly passive system for communication and meteorological satellites.

- **Nuclear power**—Nuclear and nuclear-electric rockets have shown advantages of several orders compared with a conventional chemical booster system in ability to deliver payloads for a manned Mars round-trip mission. When nuclear-electric and nuclear rockets are compared, as on the accompanying chart, the figures depend on the specific powerplant weight attainable with electric propulsion and the specific impulse attainable with the nuclear rocket.

In general, if specific weight is 10 kg/kw (22 lb./kw), electric-propelled vehicles will require less initial weight than nuclear rockets or conventional chemical systems for the same mission of more than 500 days. As the specific weight is reduced, the trip time for equal initial weights for nuclear and electric rockets moves toward lower values, reaching about 500 days and 400 days for specific weights of 6 kg/kw and 4 kg/kw, respectively.

Several studies have shown that the shielding requirements during passage through radiation belts and for the protection of crews during solar flares may amount to as much as 100 gm/cm^2 of graphite for a manned Mars mission. However, W. E. Moeckel of NASA reports that studies also show that during the outward portion of the mission, propellant is more than adequate to provide this shielding—both for nuclear rockets and for electric propulsion.

For the return trip, electric-propelled spacecraft would carry, for the best mode of operation, additional propellant equal to the shielding necessary for protection against solar disturbances. Instead of slow descent through the radiation belt and consumption of propellant during the last portion of the return trip, a re-entry landing vehicle would be used to return the crew to Earth from the electric-propelled spacecraft.

For nuclear rocket vehicles, the best operation mode depends on the solar-flare shielding required. Further, utilization of a re-entry landing vehicle instead of a final Earth-capture propulsive-impulse produces the lowest initial weight for high values (about 100 gm/cm^2) or very low values of shielding. If the required shielding is equivalent to the propellant weight needed for the final Earth-capture impulse, the best initial weights are obtained by using propellant to generate some of the impulse for capture. The

Payload for Space Probe Missions
[From Jet Propulsion Laboratory data]

MISSION	PAYLOAD, LBS.			
	Electric propulsion 25,000 lb. initial wt. 6250 lb. powerplant wt.		Nuclear rocket 79,000 lb. initial wt. "advanced" reactor	Chemical rocket 300,000 lb. initial wt. H_2-O_2 propellant
	$\alpha = 6$ kg/kw	$\alpha = 12$ kg/kw		
Mars Orbiter (500-mile orbit)	11,600 (250 days)	7,600 (250 days)	18,500 (230 days)	30,000 (230 days)
Jupiter Flyby	12,200 (500 days)	8,300 (500 days)	15,000 (500 days)	38,000 (700 days)
30 Out-of-Ecliptic	8,700 (232 days)	4,400 (232 days)	4,000 (232 days)	No mission
Solar Probe (0.094 A.U.)	9,000 (200 days)	4,600 (200 days)	No mission	No mission
Pluto Flyby	6,300 (1100 days)	2,000 (1100 days)	No mission	No mission
Saturn Orbiter (2,000-mile orbit)	5,200 (1000 days)	1,100 (1000 days)	No mission	No mission
Jupiter Orbiter (2,000-mile orbit)	4,000 (900 days)	300 (900 days)	No mission	No mission

Electric Rocket Engine Program
[Current Status]

	I_{sp} (sec)	Efficiency	Test Time Hrs.	Sp. Area Sq.Ft./kw
ELECTROSTATIC ENGINES **0.5 KW Surface Contact Ion (Hughes)** Circular Strip Type Linear Strip Type	4500	40	>200	
0.5 KW Electron Bombardment Ion (Lewis)	5000	70	>200	.34
2.5 KW Surface Contact Ion (Hughes) Circular Strip Type Linear Strip Type	7600	62	200	.08
3.0 KW Electron Bombardment Ion (EOS) **MW Ion Engine (Goal)**	7000	75	100	.10
ELECTROTHERMAL ENGINES **30 KW DC Arc Jet (AVCO)**	1320	45	250	.0004
250 KW DC Arc Jet (AVCO)	2200	36	2	.0004
15 KW Resistojet (Lewis) **(MW Arc Jet Engine Goal)**	850	75	>50	.003
ELECTROMAGNETIC ENGINES **7.0 KW Coaxial Plasma Gun (GE)** **(MW MHD Engine Goal)**	6000	43	60	.042

relative initial weights required for nuclear and electric rocket propulsion were not significantly changed by including the requirements for shielding.

● **Design goals**—An accompanying table compares the payloads that could be attained by an electric-propelled space vehicle launched by a *Saturn IB* with those possible using larger nuclear and chemical rocket vehicles. The conclusion to be drawn from this chart and other data is that a single electric-propelled space vehicle, launched by what can now be called a medium-sized booster, can accomplish most of the unmanned exploration missions within our solar system.

Another table shows NASA's electric engine design goals. It covers the application of electric propulsion to satellite position control and to prime propulsion of interplanetary spacecraft. The goals for position control include power levels of 200 watts to several kw, 10 to 50,000 hours life and 15 to 40 lb./kw specific weight for the entire power-thrustor system.

The goals for prime propulsion include up to 30 mw of power with 10 to 30,000 hours life and a specific weight of 10 to 20 lb./kw for manned and up to 30 lb./kw for unmanned flight. High reliability is essential.

Schwartz lists the following objectives of NASA's electric propulsion program:

—Develop, test and evaluate laboratory engine models;

—Provide the technology for the development of:

1) high-power prime propulsion systems, and

2) low-power position-control engine systems;

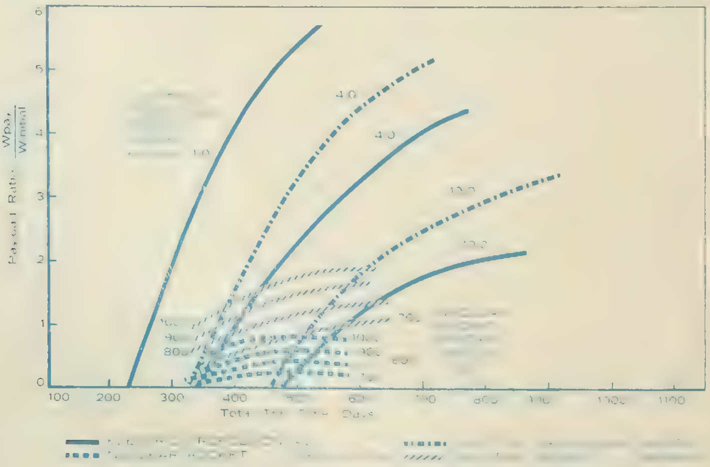
—Continually investigate advanced concepts in a time frame reasonable and consistent with potential national requirements.

● **How they work**—The electrostatic or ion engine concepts develop thrust by ionizing the propellant, such as cesium or mercury, and then accelerating the ions by electrostatic field forces. At the exit of the ion accelerator, electrons are injected into the beam so that it will be neutralized, which is essential for the production of thrust.

The two types of ion engine concepts, the electron bombardment engine and the surface contact engine, differ in the manner in which the propellant is ionized. The electron bombardment ion engine shows good performance for the 4,000 to 7,000-seconds impulse range, whereas the surface contact engine offers the highest efficiency for ion engines for impulse values above 7,000 seconds.

The electrothermal devices—examples being the arc jet and the resistojet—develop thrust by electrically heating a gaseous propellant, such as hydrogen, and expanding it through a nozzle. The difference between the arc jet and the resistojet concept lies in the manner in which the propellant is heated. In the arc jet, the propellant is heated by passing it through an electric discharge, while in the resistojet, the propellant is heated by passing it between electric resistance heated elements. The range of specific impulse for this group of engines is from 700 to greater than 2,000 seconds.

The electromagnetic or magnetohydrodynamic (MHD) engine concepts develop thrust by accelerating a gaseous propellant plasma, such as argon or



PAYLOAD RATIO FOR ROUND-TRIP MARS MISSION

25 Days [illegible] Mars Orbit

[illegible]

POSSIBLE SPACE MISSIONS FOR ELECTRIC PROPULSION

MISSION	I_{sp} (SEC)	POWER LEVEL
Position control of Scientific and Communication Satellites	300- 5,000	200 Watts-10 KW
Prime Propulsion of Unmanned Spacecraft Scientific Probes—Solar and Out of the Ecliptic	4,500- 7,000	100 KW-500 KW
Planetary Exploration Probes—Venus, Mars, Jupiter	2,000- 7,500	300 KW-500 KW
Lunar Supply Ferries (Freight Transfer) Transfer)	1,700- 5,000	1 MW-4 MW
Prime Propulsion of Manned Spacecraft	5,000-20,000	10 MW-30 MW

ELECTRIC ENGINE DESIGN GOALS

MISSION	POSITION CONTROL	PRIME PROPULSION
Power Level	200 W-1 KW	Up to 30 MW
Life, hours	10-15,000	10-30,000
Specific Wt LB/KW (power plant and thrustor)	15-40	Up to 30 LB./KW

NASA RESEARCH AND TECHNOLOGY PROGRAM

(Theoretical and Experimental)

ELECTROSTATIC PROPULSION ENGINES (ION, COLLOID)
- **Thrustor:**
  - Ionization
  - Ion Acceleration
  - Beam Neutralization
  - Materials
  - Instrumentation (Diagnostics)
  - Ionizer Fabrication
  - Scaling and Clustering
- **Electrical Components and Circuitry**
  - Power Conditioning and Controls
  - Insulation
- **Propellant Storage Feed and Vaporization**
- **Advanced Concepts**

ELECTROTHERMAL PROPULSION ENGINES
- **Thrustor:**
  - High and Low Power Electrode Erosion
  - Heat Transfer
  - Scaling
  - Ionization and Dissociation Losses
  - AC vs. DC
  - Materials
  - Energy Transfer (all loss mechanisms)
  - Diagnostic Techniques
- **Propellant Selection, Storage and Feed**
- **Electrical**
  - Power Conditioning
  - AC vs. DC
  - Arc Starting
  - Time Variations
  - Materials (insulators)
  - Switching
- **Advanced Concepts**

ELECTROMAGNETIC PROPULSION ENGINES
- **Plasma Physics**
  - Electrical Conductivity of Gases
  - Plasma Generation and Acceleration
- **Plasma Dynamics in a Magnetic Field**
- **Design Optimization of Electrodes**
- **Electrode Cooling**
- **Energy Storage**
- **Magnetic Fields (light weight magnets)**
- **Materials**
- **Chemical Reactions Involving Gases and Materials**
- **Scaling**
- **Diagnostic Techniques**
- **Propellant Selection Storage and Feed**
- **Advanced Concepts**

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Ion Engine Progress . . .

hydrogen, by coupled electric and magnetic field forces. The two general types of MHD accelerators are pulsed and steady-flow plasma accelerators, which differ in the manner in which the electromagnetic forces that accelerate the plasma are created and the manner in which the plasma is generated.

The different MHD engine concepts show promise for covering the range of specific impulses from 700 to greater than 10,000 seconds, says Schwartz. It is too early at this time to predict which of these engine concepts will best satisfy a potential requirement, since the present effort is on very small engine modules in the several-kilowatt power level. The performance and engine life characteristics could be appreciably different when these modules are scaled into large-mission-type engines in the thousands of kilowatt or megawatt power level.

● **The next step**—In all three engine categories, investigations were started on small engine sizes with the ultimate goal to develop thrustors in the megawatt power level. Once a small thrustor is developed to produce high performance with long life and reliability, scaling and clustering techniques will be devised to produce larger systems. By this building block technique, NASA hopes to attain megawatt-power-level systems.

● **Ion-engine technology**—In a recent effort to advance the status of the electrostatic engine, Hughes Research Laboratory, Malibu, Calif., designed, fabricated and tested for NASA a 0.5-kw (3-millipound-thrust) circular strip-type surface contact ion engine which provided 40% efficiency at a specific impulse of 4,500 seconds and tested for greater than 200 hours. This thrustor demonstrated efficiencies as high as 85% at 8,700-second impulses and was scaled into 2.5-kw-power-level size.

Hughes also has conducted studies on the linear-strip-contact ion engine, which has presented fewer engineering problems for scaling than the circular-strip-contact ion engine but has comparably good engine efficiencies. A 0.5-kw electron bombardment ion engine concept that evolved from in-house research at the Lewis Research Center is 70% efficient at 5,000-sec. specific impulse. This concept shows good performance between 4,500 and 7,000-sec. specific impulse.

Electro-Optical Systems designed and developed a 3-kw cesium electron bombardment ion engine for NASA. During FY 1964, emphasis will be placed on obtaining several hundred hours of test time on these 3-kw engines, improving their performance, an studying techniques for scaling or clustering these engines into higher powe levels. Schwartz says that the most serious problems relating to the ion thrustor are:

—*Ionization.* A high percentage o propellant atoms must be ionized wit minimum power utilization.

—*Ion acceleration.* Ions must b accelerated through the engine with minimum of electrode erosion.

—*Beam neutralization.* The io beam must be 100% neutralized by injecting electrons from a cathode sourc into the beam at the accelerator exit Ground-testing of an ion engine in vacuum tank facility does not provid absolute proof of the amount of bean neutralization. The tanks cannot simulate the space environment, since th walls of the vacuum tank can emi electrons into the exit of the engine an hence neutralize the beam. For this reason, early flight tests are required.

In materials and other areas, ther are problems in the development of ionizer materials that will permit maximun propellant utilization efficiencies wit minimum heat-radiation losses.

The problem of scaling and clustering involves maintaining minimun weight and size and high performanc in a thrustor. The problems of powe conditioning and control design are ver severe for the high-voltage ion thrusto Transient effects from the power conditioning have affected thrustor performance in the low power engines.

● **Advances in the art**—Most noteworthy arc jet-thrustor accomplishmen during FY '63 was Avco's re-evaluatio and creation of a new theoretical mode of the energy transfer process that le to the redesign, fabrication and experimental testing of a so-called long-nozzle throat "core flow" arc-jet model. Experiments on this new engine produce impulse levels heretofore thought un attainable with radiation cooling in a arc-jet engine.

In July, 1963, a 250-kw radiation cooled engine was operated for a shor duration with a specific impulse o 2,200 seconds at an efficiency of 35% The primary effect of this work ha been the re-evaluation of arc-jet performance limitations. Thus, a new an challenging problem has been create that is, to determine what are in fac the performance limitations of larg arc-jet devices. NASA is confident tha the engine efficiencies can be improve in the high-specific-impulse range o 2,000 to 2,500 seconds.

During FY '64, emphasis will b placed on performance in an effort t

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ttain high efficiency for the high-pecific-impulse range for the 250-kw ngine. Approximately 12 contracts are urrently involved.

- **Problem areas**—In electrothermal esearch, electrode erosion and ionizaon and dissociation are perhaps the iost serious problems. Scaling the 30-w arc jet to higher power levels creted a high rate of electrode erosion; pproximately 40 to 50% efficiency is st due to the energy that goes into ie dissociation and ionization procses.

In regard to the electromagnetic ennes, four different MHD plasma acleration concepts are being investiated to determine their feasibility for ace propulsion application. Recent sts on the GE two-stage coaxial asma gun have produced good efficiencies, approximately 40 to 50% at 500 seconds specific impulse. This acelerator has shown the most promise to ate for propulsion application.

In FY '64, emphasis will be placed ı improving performance and increasg the pulse-rate capability to provide gher levels of thrust. Increased effort ill be applied to plasma diagnostics to etermine the mechanisms which govn the coupling of partially ionized ises with magnetic and electric fields. he development of lightweight capacirs for rapid pulsing accelerators is an ea which demands much attention. pproximately 11 contractors are workg on these problems.

Another important technology area, wer conditioning, is required for all ree engine concepts. To exploit sensiy and fully the capabilities of electric opulsion, considerable care must be ven to the design of the electrical wer conditioning and propellant conol subsystems. The transient effect om the power-conditioning system can ppreciably affect the performance of e thrustor.

Several small power-conditioning stems have been built and are being sted in connection with early *SERT I* pace Electric Rocket Test) flight test ogram, and Schwartz says that perps a greater emphasis on this subject n be anticipated in the future.

Factors which must be considered clude electrical efficiency, thermal conol, minimal mass, radiation resistance, gh voltage isolation, supply regulan and matching of the static and namic electrical load characteristics the thrustor and, above all, reliability. ace environmental conditions on elecnic equipment must be investigated.

A pacing factor for obtaining great wer for electrical propulsion is deloping the nuclear generators. Yet me experts consider such development s difficult than it was to get a large emical-booster technology. ■

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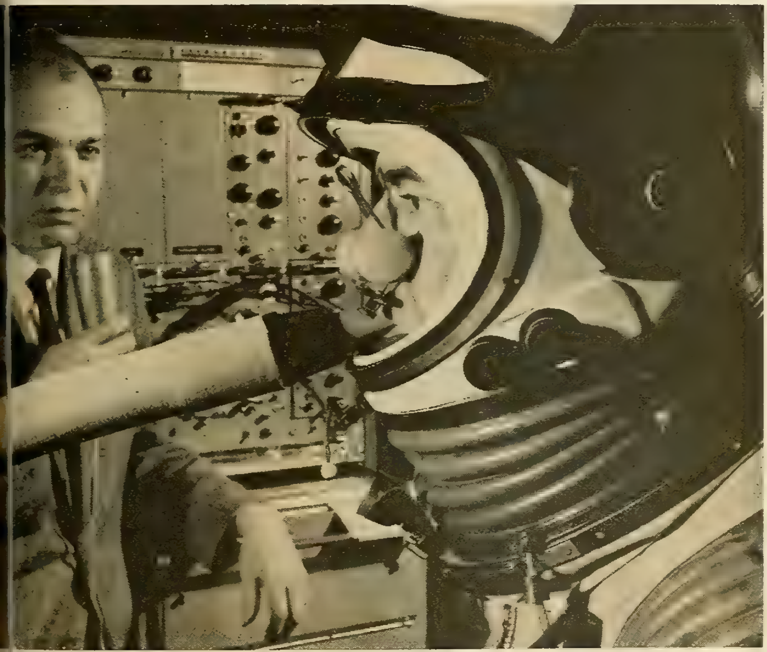
Biotechnology Research Pushed by Big Companies

Congress cuts medical, bioscience and human factors funding heavily, but long view is for steady growth



SPECIAL BICYCLE called "ergometer" is used at Republic Aviation Corp. to measure oxygen consumption and metabolic rates involved in final design of experimental lunar exploration suit for Project Apollo.

HOW MUCH NASA will spend in the fields of aerospace medicine and biotechnology during the next decade is difficult to conjecture—although it is safe to say the amount is on the rise. However, these disciplines are ones all major companies have recognized they must pursue if they are to develop the systems capability necessary to win the large spacecraft awards.

The place where well-laid programs have been overturned has been in Congress, which generally has been cool to medical research by the space agency. This year, it cut NASA's aerospace medical budget from $16.7 million to $11 million; bioscience programs from $35.2 million to $21.2 million; and human factors systems (biotechnology and human research) from $18.2 million to $13.2 million.

These offices probably will have to absorb further cuts, since the actual amount appropriated is much lower than the authorization.

All these offices still suffer from the stigma of earlier times when organizational efforts in the life sciences offices were not defined well enough to distinguish their programs from those already being carried out by the Air Force. And, with some exceptions, the biomedical community has done a poor job of explaining—and thus selling—itself to the budget-makers.

In advanced research, however, there can be little doubt that the future lies with NASA. Unless a major policy decision is made to give the manned orbiting space station to the Air Force, NASA's Office of Biotechnology and Human Research in the Office of Advanced Research and Technology (OART) holds the key to bioengineering developments of the future.

One of the most active areas in the next few years will be that of researching, developing and finally testing prototype models of oxygen-supplying life-support systems for space.

The bulk of advanced research for man in space is carried out by the Office of Biotechnology and Human Research. Some work, however, still is funded by the Office of Manned Spaceflight as a carry-over before the establishment of the new office headed by Dr. Eugene B. Konecci.

- **Life support systems**—The most extensive attempt to test a completely integrated 30 to 60-day life support system has been made under a NASA contract with the Boeing Co. of Seattle. The five-man prototype system employs a superoxide system for carbon dioxide removal and oxygen regeneration and an "activiated sludge" unit using microbes to handle waste products.

Contamination by tubing and chemical materials in the handling equipment caused the abortion of the run

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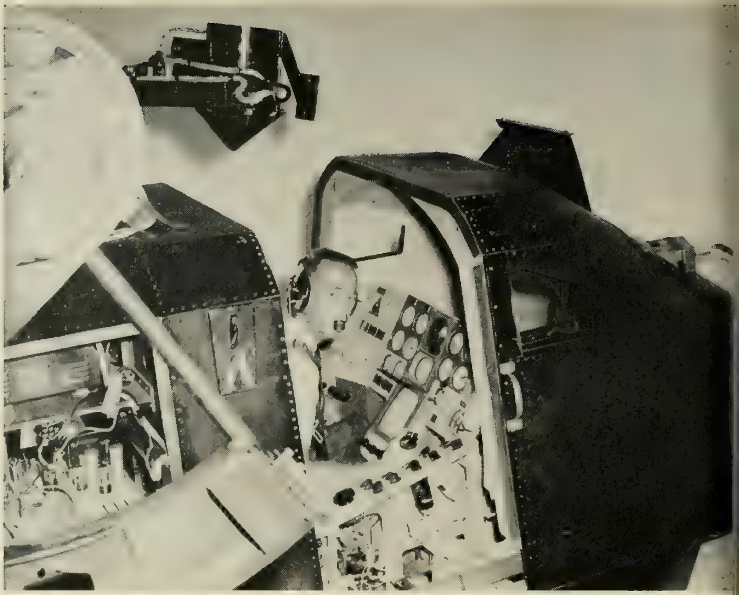

LEFT: Prototypes of space suit and life-support back pack being developed b
Hamilton Standard Div. of United Aircraft Corp. for Manned Spacecra
Center's Apollo program. International Latex Corp. is subcontractor on su
development. Rubber bellows at joints of arms, legs and torso provide greatl
increased mobility under pressurization. RIGHT: Astronaut M. Scott Carpente
in Ling-Temco-Vought's Manned Space Flight Simulator.

after five days, however, and pointed up the difficulties in handling these materials.

NASA will schedule a 30 to 60-day integrated systems run early in 1964, if these problems can be worked out. In addition, a 3 to 6-month life-support system for four men has been contracted with General Dynamics, and request for proposals for a one-year system will be issued soon.

One of the biggest problem areas in life support subsystems is in the collection and conversion of carbon dioxide, according to Crew Systems Division director Dick Johnson. The Manned Spaceflight Center, which is looking at subsystems development up to 30 days, is studying molecular sieves, organic and inorganic membrane systems, electrodialysis and turboexpanders to collect carbon dioxide and deliver it to a physical oxygen-conversion system.

After the current study contracts are completed, one or two of the most promising systems will be selected for further development, Houston officials said.

Other subsystem work is concerned with waste management, one of the most serious problems facing the developers of life support systems. Biofuel cells, which generate electrochemical power, look most promising at present.

• **Food and water**—Most of the integrated life support systems rely on freeze-dehydrated foods that must be reconstituted with water before eating.

However, some advanced thinkers at NASA are tossing around the idea that perhaps man can someday eat his environment—that is, synthesize food directly.

For example, possible types of lunar rocks are now being studied. Dr. Michael G. Del Duca, chief of biotechnology for the NASA headquarters office, says that it may be possible to generate simple inorganic molecules from lunar and planetary material, polymerize them, and build up to complex polyorganics. According to Del Duca, the process will require study of several possible solutions:

—Through some low-energy source, such as RF, nuclear, or thermal, generation of organic precursors using simple natural materials like rock.

—Synthesis of complex organics, such as sugar, from such precursors as formaldehyde.

—Alterations of metabolic processes to accommodate predigestion at the molecular level.

—Control of metabolic requirements varying atmosphere around the man.

Water generally is not a problem, since it can be reclaimed almost with 100% efficiency from metabolic wastes.

• **Protective garments**—Several contracts have been let for studying mechanical locomotion methods for propelling man and for anthropometri
and nonanthropometric protective er
closures. Thermal problems are amon
the most difficult features of designin
space suits. While the Moon will be
severe enough challenge with its tre
mendous ranges of diurnal tempera
tures, OART is thinking ahead to ex
ploration of Venus, with a reporte
800°F average temperature.

At the same time, Del Duca repor
that he would like to see articulate
systems for propelling man in spac
that would not require large vehicl
and equipment around him.

Besides systems that can be used fo
repairing and exploring tasks outside th
vehicle, the NASA official said he
interested in escape units for return
individuals from orbit, the Moon ar
the planets.

• **Repair and maintenance**—Cu
rent studies are aimed at defining wh
failures man will be able to repair, ar
establishing design criteria for har
ware in general that man can mainta
in space. The scientist must also tal
into account what psychological stress
they may be adding to the man by r
quiring him to be responsible for th
equipment.

• **Bioengineering**—Konecci conti
ually has emphasized the need for in
proved bioinstrumentation, as ha
other space medical experts.

The most far-reaching endeavor

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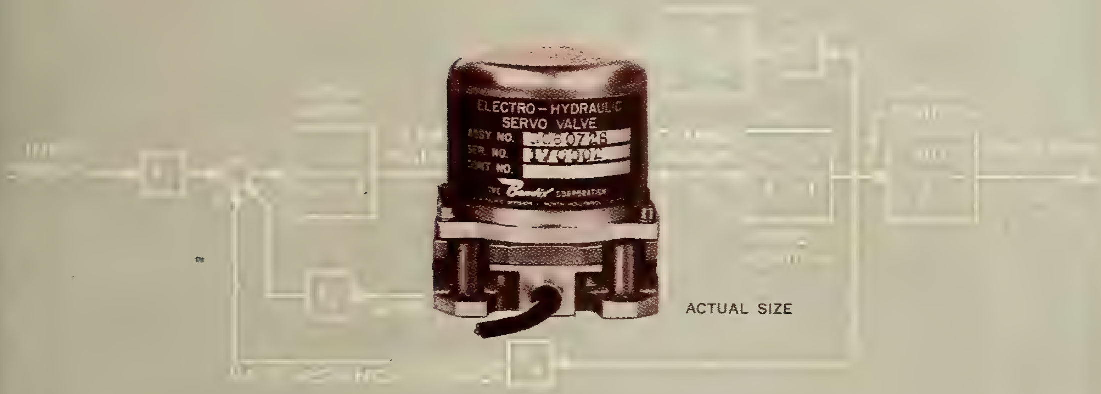

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bioinstrumentation at present is the PIAPACS (psychological information, acquisition, processing and control system), which will be used mostly for research in the next few years.

Essentially, the system will gather necessary information about the subject's functional state, feed it to a computer and counter any undesirable state by providing control signals to the vehicle's environmental control and perhaps the flight control systems. Information also will be displayed in such a way that a medically naive subject also can understand the situation and act if necessary.

Ultimately, OART officials say that no output or input would be needed from Earth, although some information would probably be telemetered back so that ground monitors could exercise some control if necessary.

While Lear Siegler, Inc., holds a contract for the first phases of the system, there will be additional contracts and in-house work at Edwards Flight Research Center, Calif.

HUMAN RESEARCH

All studies in this area are conducted under the direction of Navy Captain Frank Vons (M.D.), on assignment to NASA.

- **Radiation**—At the recent International Astronautical Federation meeting in Rome, it became very evident that the Soviets are far more concerned with radiation than is the U. S. While NASA generally is satisfied with its current program on ionizing radiations (mostly with the AEC and DOD), OART is looking ahead to the possible effects of the other portions of the electro-magnetic spectrum. Programs to develop instruments to measure exposures by new unifying concepts such as linear energy transfer (LET) are being shared with DOD and industry.

Secondary radiations—those that may result from interaction of solar flares with the shielding material on the spacecraft—will be a subject of considerable interest. Konecci pointed out that his office must determine whether it may be better not to have shielding at all.

While NASA offices doing research in the physical sciences will look at the properties of materials, Konecci's office eventually will use animal experimentation to determine the long-term effects of various radiations.

Within the next few years, the office hopes to compile data for two handbooks that can be used by shielding engineers in the design spacecraft. The first, shared with the Navy, will computerize data on dosimetry and physiological effect, shielding data, and satellite data. Ship geometry and construction designs can be tested by computer to arrive at pre-flight data on expected radiation intensity in any portion of the ship. Thus, design can be corrected if necessary.

The other would be a mathematical model of man to determine what organs are most susceptible to radiation and the permissible doses for the various parts of the body. This also would be used in shielding design.

Development of the laser has brought new implications to the biologist and physiologist. One of the possibilities Konecci's office will investigate is that certain materials or crystals in the body may create localized damage in vital organs when excited by certain energies—turning them into lasers of sorts. While the NASA officials admit this is a remote possibility, it cannot be ruled out until investigated. Effects of light, ultraviolet, magnetic fields and other wavelengths also will be studied.

Magnetic field effects are particularly interesting because NASA feels they hold promise of effective shielding in space. This field—which, in effect, pushes the ionizing radiation sideways thus diverting it or creating a relatively harmless orbit around the ship—eliminates the chance of secondary radiations as well as primary.

Designs of spaceships utilizing magnetic fields for radiation shielding are now limited to toroidal shapes, with the magnetic field source mounted in the middle. Other spaceship shapes apparently expose the astronauts to the magnetic fields. Thus, NASA will study the effect of such exposures.

- **Weightlessness**—Konecci's office is advocating a manned orbital research laboratory as the only means weightlessness can adequately be studied as a unique phenomenon. Until program approval is secured, however, the office will support some experiments in the *Biosatellite* project to study weightlessness.

One of the biggest technical debates on weightlessness is whether space stations should have zero-g or a built-in capability to simulate the Earth's gravity. One compromise now gaining favor is that a centrifuge could be included in a large stationary platform so tests could be made periodically to check on the astronaut's condition.

Major vestibular research will continue under contract by Dr. Ashton Graybiel at the U.S. Naval School of Aviation Medicine. His group is studying the basic mechanisms by which force fields produce disorientation and

POSSIBLE ADVANCED MISSIONS

MISSION NAME	ORBIT (N. MI.)	NUMBER IN CREW	DURATION	DATE	BOOSTER	COMMENTS
Manned Orbital Laboratory	250	4 to 6	One year with 30-to-90-day resupply	*		Basic research for man-in-space, non-rotating with centrifuge capability
Semi-permanent Orbital Base	300	12 to 14	Several years, 6-month resupply	1969	Saturn V	Earth and space observations, communications and experimentation
Lunar Base		12 to 24	6-month duty	1969	Beyond Saturn V	Could be expanded
Recoverable Manned Orbital Logistic System	*	*	1-3 days, but with 100-flight mission capability	*	Reusable rocket, 1 or 2 stages, nuclear or chemical	Manned cargo system and payload delivery to orbital velocity
Advanced Aeronautical Systems (on Earth)				1970		Broad category, including V and STOL and supersonic
Nuclear Manned Orbital Transfer Systems	*	2 to 3	6-mo. mission	1970		Rendezvous and orbital changes, rescue, support and maintenance
Manned Interplanetary Exploration		3	1 to 2 years	1971-1973	Nuclear stages	
Permanent Orbital Base		50	5 to 10 years, 6-mo. intervals	1973		One million pounds gross weight, meteorological, communication and other operational uses
Planetary Bases (Venus, Mars)		12 to 24	1 year tour, 2 years transit, 10 years life	1975-1977		Very advanced
Advanced Planetary Missions (Mercury and beyond Mars)		5	1 to 2 years	1977-1979		Will require rapid transit

* Not determined

Motion study. Induced rotation of a Manned Orbital Research Laboratory under study by NASA, vhich would provide artificial gravity for its crew, could also introduce unwelcome twist, tumble, spin and vobble in space. □ Because these motions can best be arrested by precision stabilization, Sperry is under ontract to NASA Langley Research Center (1) to make dynamic analyses of the types f motion which may be encountered; (2) to derive control laws which may be applied to he resultant problems; (3) to generate control concepts which will guarantee station staility. □ Because orbital times up to a year are under study, a manned station presents unique challenge in control. Sperry experience in gyroscopics, aerospace control, unlersea stabilization logically suits us for the task. General Offices: Great Neck, New York.

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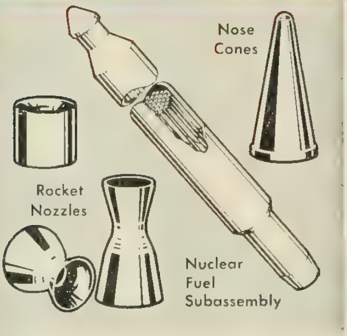

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disturbances through the organs of the inner ear.

New methods of communication may be investigated by the OART office. Since the rarified atmosphere and special clothing will cause difficulties in the transmission of sound, there may be a need to find other solutions. NASA officials indicate they may be interested in studies which employ direct communication with the auditory center of the brain, or by electrical impulse on the skin.

- **Toxicology**—All materials and substances which might conceivably come into contact with the space traveler will be investigated in the next few years. The recent Boeing experiment especially has pointed up the need for basic data.
- **Personnel selection**—According to NASA psychologists, there are two main problems that will be attacked in the coming months. The first, getting definitions of which people are most suited for long-term spaceflight, and the second, setting up experiments to study dynamics of small groups in isolation.
- **Body systems**—All major body systems in the dynamic state will be studied. The cardiovascular system is of particular interest right now, and emphasis will be placed on the effects of low gravity and high-g states. NASA will use this information to obtain design parameters on accelerations possible.

Other body systems of interest, especially in relation to weightlessness, will be the central nervous system, the gastro-intestinal tract, respiratory, musculo-skeletal, and endocrine. NASA currently is investigating mineral dynamics and loss of calcium caused by disuse of the muscular system through bedrest, with the cooperation of a number of military hospitals.

- **Psychophysiology and behavioral sciences**—NASA will continue its interest in man's ability to receive, acquire and store information, retrieve it, manipulate it and transmit it. Konecci said that his office will study this entire sequence on a very basic level to determine how much energy is involved in this process. The ultimate goal would be the ability to predict in advance what his performance capability would be to do a specific job.

In the next few years, the office also will be interested in determining man's natural rhythms and circadian patterns, cerebral mechanisms and special psychic and physiological states.

MAN-SYSTEM INTEGRATION

The key research goals for this year, according to program chief Robert F. Trapp, are oriented toward anticipating missions and the possible function of man-in-space. This office must try to determine what the role of man will be in advanced missions, so that requirements can be given to the Human Research and Bioengineering offices. The work now going on in this office will set the pace for much of the OART contracts for the next few years. Part of the burden of justifying a manned orbital research laboratory will fall on this office.

Ames Research Center, which does much of the work for NASA's Biotechnology and Human Research Office, is undertaking a number of studies aimed at understanding the tasks of pilots in interplanetary missions. This may involve piloted simulations and flight tests designed to show extent of the operator's capabilities.

Other studies will involve refining ideas of crew members in lunar bases—what types of educational backgrounds should be represented and what skills they should be taught. Ames also is studying rendezvous methods. Data from these studies will be incorporated in design of spacecraft.

- **Nuclear vehicles**—The office also is continuing study of the general problems of nuclear vehicles and shielding device techniques. The shielding handbook mentioned earlier in this story will be the responsibility of this office.
- **Boosters**—Another project upcoming in this office will deal with the role of man in controlling or integrating into the control loop of recoverable boosters. NASA will seek to answer whether man should play a part, what kind of guidance and control system could be employed best, and how best he would affect the reliability of the system.
- **Experiment packages**—This office also is responsible for integrating the complete flight experiments, the requirements for which usually have been generated by one of the other offices.

Several dozen experiments in the biotechnology area will be funded this year, in cooperation with the Offices of Space Sciences and Applications. One of the most significant will be the 14 to 30-day primate flight experiments on *Biosatellite*. This office will be responsible for demonstrating and checking out all these experiments, which eventually may include some to be performed on man. Each subject, whether monkey or man, probably will be used for severa experimental purposes.

- **Advanced concepts**—Some of the most far-reaching ideas about man's capabilities may one day be generated by this office, because of its responsibility to protect him in unnatural environments.

In some cases, this task of giving him food, water, oxygen and the ability to withstand enormous stresses and long periods of time away from earth may be so immense that conventional means may be so impractical as to be prohibitive. Thus OART is looking ahead at the possibility that man can be physiologically equipped to adapt to the environment of other planets or deep space.

The cyborg study, now under contract to Hamilton Standard Division of United Aircraft Corp., already is investigating these possibilities. According to Del Duca, there already has been experimentation with animals breathing directly in a saline solution with the aid of electrodes implanted to convert the water to usable oxygen and hydrogen.

In addition, means of reducing metabolic needs during the prolonged travel periods to distant planets are being considered. These may involve inducing a hypothermic state or hibernation by drugs.

Other advanced studies will be concerned with attempting to build human analogs—mathematical models or dynamic models of subsystems—to determine stress limitations without having to experiment with humans.

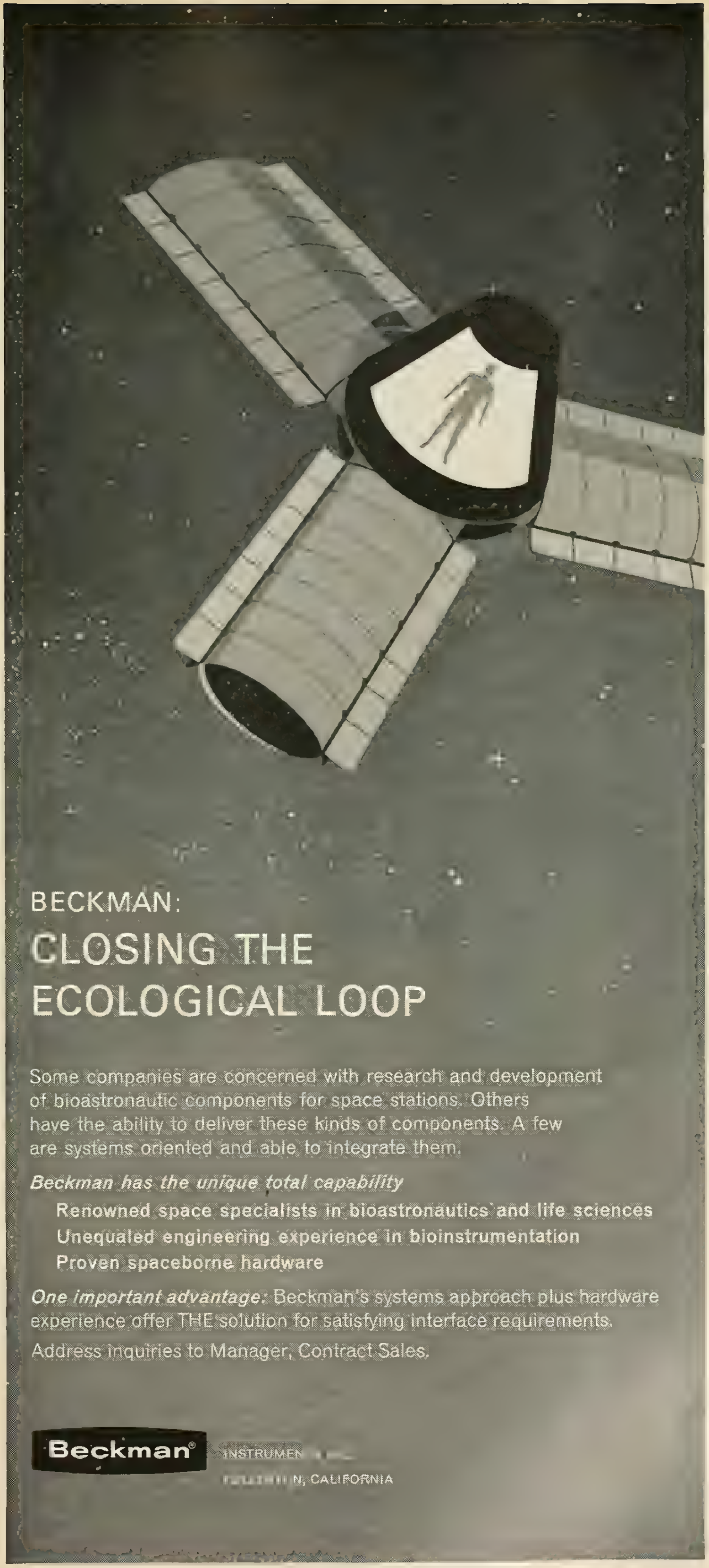
• **Flight experiments**—Dr. Konecci has issued a standing invitation to industry, universities and other Government laboratories to submit unsolicited proposals or pre-proposals on research experiments. Sample forms are available from his office.

In general, experiments must be "meaningful, and far enough in advance, to give design data that will insure the success of future manned flights and considerably reduce the research, development, cost and time required to obtain an operational system."

Flight programs may involve high-altitude balloons for equipment and men; operation of an X-14 for human aircraft control and display data; X-14 for lunar and planetary landing and takeoff simulation; small and large primate and other animal spaceflights; and eventually manned research laboratory to develop technology and subsystems for space stations, lunar bases and interplanetary missions.

Konecci said his office is particularly interested in one-shot recoverable or non-recoverable experiments that attempt to answer specific critical questions but are simple to operate.

• **Other agencies**—DOD has done quite a bit of work for Biotechnology and Human Research, and according to Dr. Konecci, this amount probably will be increased in coming year. The office works through the Life Sciences sub-panel of the Space Support, Research and Technology panel of the Aeronautics and Astronautics Coordinating Board. ■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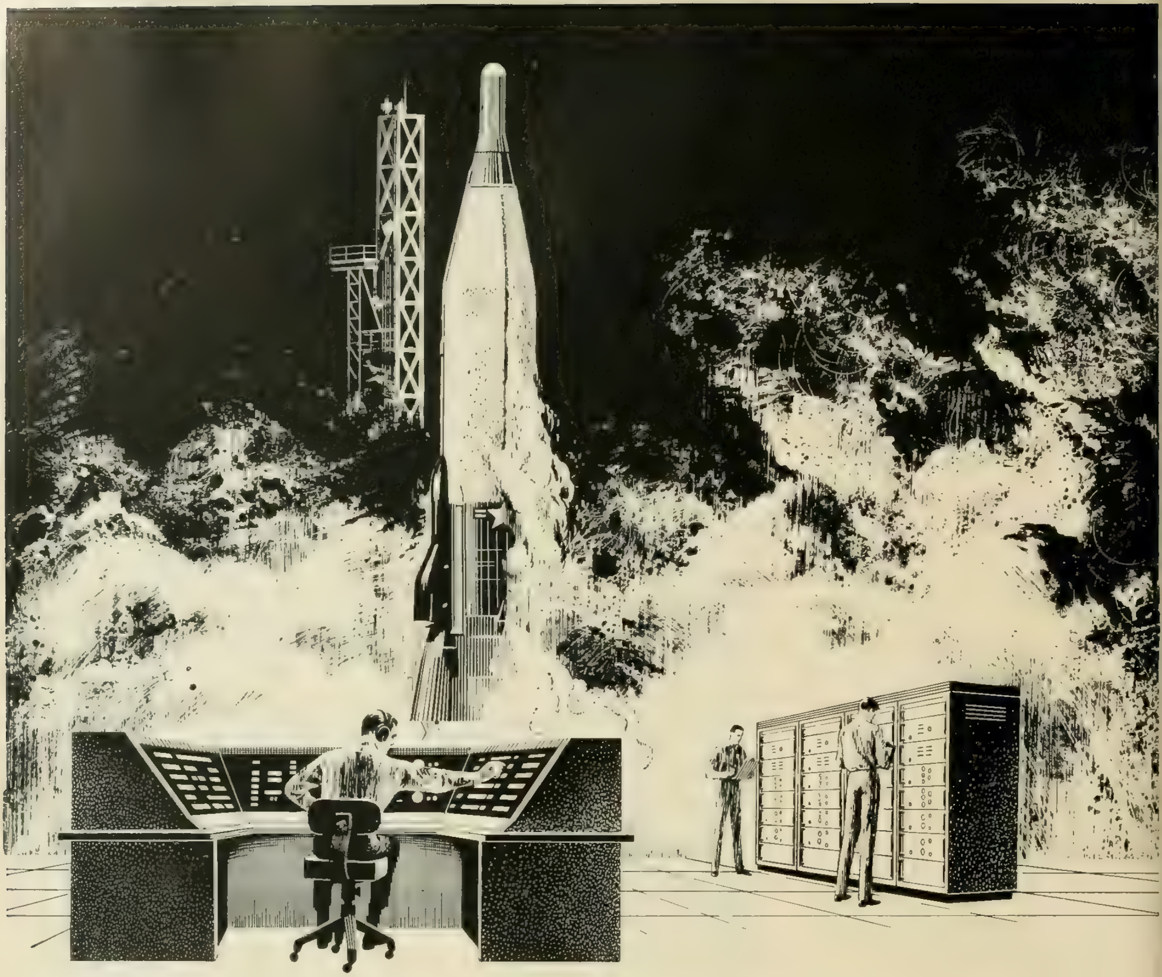

Marquardt needs electronic engineers

Marquardt's latest assignment in the missile trainer-simulator field is to develop and produce the Atlas E and F missile launch crew procedure trainers for the Air Force Ballistic Systems Division. The new Marquardt trainer represents another advance in simulation technology since it is a completely solid-state digital system. It will accurately simulate all operational procedures — from alert to launch — and will encompass the complete spectrum of malfunctions. The Marquardt systems will be used at various SAC bases to train missile combat crews who are required to operate, maintain, and control the Atlas.

Marquardt's advanced capability in trainer technology is also exemplified in other military applications, including the T-10 navigator trainer for B-52 bomber crews, T-4 manual aircraft control and warning site trainers, T-8 trainers for 412L automated air defense systems, and trainer-simulators for the GAM 77 (Hound Dog) and GAM 72/A (Quail) missiles.

Expanding programs, coupled with continuing company-sponsored research and state-of-the-art contracts, are responsible for the new assignments now open at Marquardt. Opportunities presently exist for experienced engineers and scientists who want to affiliate with a dynamic company, well diversified in electronic systems, as well as control systems, airbreathing propulsion, and aerospace research.

Select senior personnel highly qualified in any of the following areas, will find rewarding opportunities at Marquardt: Electro-Optical Systems; Digital Systems Analysis and Logical Design; Advanced Analog and Digital Simulation Systems. Please write in confidence to Mr. Fred Clark at the address below:

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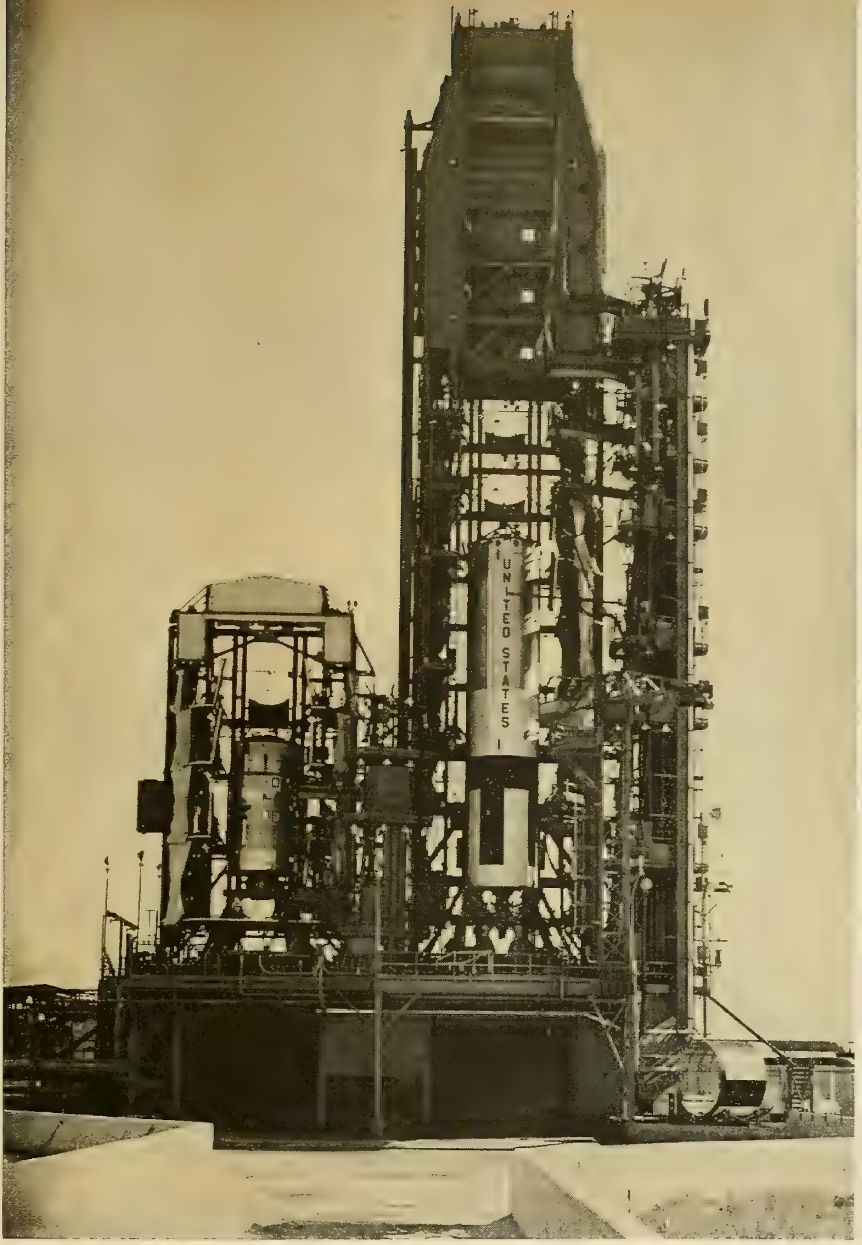
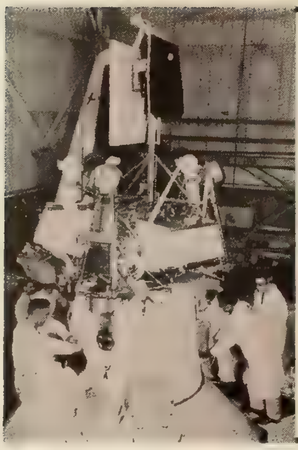


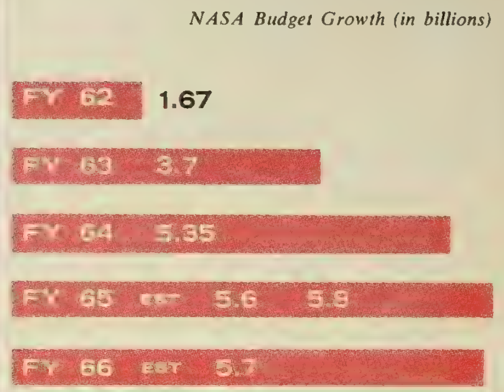
FIRST GEMINI/TITAN II booster on erector at Cape Canaveral.

THIRD ANNUAL NASA ISSUE

Part II

FUNDING & PROCUREMENT





NASA Budget Growth (in billions)

NASA/funding

Fund-Cut Threatens Plan to Ask For $250-Million Supplemental Funding

Election-year factor and other uncertainties cloud outcom big fight will be over FY '65-'66 requests for higher budge

SENATE APPROVAL of the House-passed $5.1-billion Fiscal 1964 appropriation bill may doom NASA plans for a supplemental budget request of $250 million.

The action also cast a dark shadow over agency plans to request a Fiscal '65 budget of $5.6 to 5.8 billion and a Fiscal '66 request estimated at $5.5 billion, but which could go as high as $5.7 billion.

Administration officials told MISSILES AND ROCKETS that it appears the budget bureau will approve FY '65 funding of only $5.5-5.6 billion. Despite NASA plans to submit an interim operating plan detailing the effects of the recent budget cuts in an effort to shock Congress into approval of a supplemental, Administration space experts are clearly skeptical of its chances of success.

Other new developments in the ever-shifting NASA budget picture include:

—The agency has won its argument with the Weather Bureau over the practicality of a meteorological satellite with a three-year-orbit capability. The Bureau has dropped its support of the satellite and has asked NASA to develop three more *Nimbus* weather satellites.

The Bureau still has not decided whether it will reverse its earlier action and continue to fund *Nimbus* operational spacecraft.

—Serious consideration is being given to cutting the M-1 engine project back to a component development program. The reason—Congressional budget cuts.

—The question of whether NASA or DOD manages the space station program is still completely open.

DOD's chances increase in proportion to the stretchout in the *Apollo* program. There won't be any room in NASA's FY '65 budget for the project, and its FY '66 funding would have to hit $6 billion or over to include it. The big roadblock could be Secretary Robert S. McNamara, who doesn't view military space projects with much enthusiasm.

Associate Administrator Robert C. Seamans, Jr., told MISSILES AND ROCKETS that the earliest date for a manned planetary mission to Mars is now 1983. This will mean a long delay in funding for large launch vehicles beyond the *Saturn V* and the spacecraft for Mars.

- *Supplemental request*—Wheth the Administration—and, more impo tantly, Congress—will buy the "supp mental" is still in doubt. As one NAS official put it, "it's in the lap of God."

He explained that it depends up such things as the mood of Congre tax-cut legislation and the expenditu of other agencies.

Some Administration space expe are privately expressing misgivin about the desirability of asking for t supplemental. They argue that the pro lem is one of timing. Congress th point out, just completed voting acti which has cut the appropriation $5.1 billion, $250 million below t $5.35-billion FY'64 authorization. I going to be difficult to convince the that anything has changed in the sh interval from November, 1963 to Ja uary, 1964.

NASA, however, has decided to ta the bull by the horns. "It's time for Co gress to decide what the space progra really is," one official declared.

He said that the issue of wheth NASA is going to get the funds it nee to fulfill its Moon program comm ments must be clearly drawn.

ECENT OVERALL photograph of construction at NASA's Manned Spacecraft Center at Clear Lake, near Houston.

As a result, the interim operating an will be submitted to Congress in e near future, a top NASA official id.

• **Casualties**—While NASA offi- ally refuses to comment on the report's ontents, informed sources told M/R will tell Congress that $150 million f the R&D cut will have to come out of anned space flight. This will include out $75 million which NASA wants spend for backup systems for the *pollo* spacecraft. Another $33-million duction in construction, principally at aunch Operations Center, is in the rds.

It also is expected that NASA may reaten to reduce funding of the Lunar xcursion Module, since it is the por- on of *Apollo* which will be needed last.

Other likely candidates include the lvanced study program, the M-1 en- ne, *Saturn V* development and the L-10A3 engine.

The source said a decision will have be made in the next few weeks on duction of the M-1 engine program to simple component development pro- am. Authorized funding in the current scal year has already been cut by ongress from $45 to $28 million. The it in appropriations will reduce it even rther, and at this point there is a seri- is question as to whether it should be ontinued as an engineering program.

The reduction in funding of the L-10A3 is possible because of the de- sion not to launch manned *Apollo* ace flights with the *Saturn I* booster.

Six of the engines make up the boost- 's S-IV second stage. Because of the ecision, four fewer stages will be re- uired.

The remaining $50 million of the propriation cut will hit the projects the Office of Space Science and Ap- lications and the Office of Advanced esearch and Technology.

The big bite will be in the former. Cutbacks in the number of follow-on observatory satellites are expected. For example, the *Orbiting Astronomical Observatory (OAO)* program will be reduced from three to one follow-on advanced satellite. Funding reductions also are expected to hit communication satellite projects until the commercial Communications Satellite Corp. decides just what type of satellite it favors for a commercial system. Money for weather satellites likewise is being doled out in small amounts, because of the dispute between the agency and the Weather Bureau over the necessity of a satellite with a three-year-orbiting operational capability.

The Weather Bureau claimed the *Nimbus* satellite was too expensive and that the new satellite was needed to replace it. Recent meetings between NASA, Commerce Dept. and Budget Bureau officials on the Fiscal '65 budget has convinced Commerce Secretary Luther Hodges of the impracticality of the Weather Bureau position. As a result, the Department has asked NASA to build three more *Nimbus* satellites. No decision has been made, but it is likely that the Bureau will return to the old arrangement under which it agreed to fund several operational *Nimbus* systems.

As far as the budget for the Office of Advanced Research & Technology is concerned, reductions in funding of *NERVA* and RIFT probably will be made. One Congressional reduction which may hurt the research centers cut to $494 million the amount approved for NASA's administration expenses.

This is far below the budget request of $560 million, and NASA recruiting probably will be slimmed down.

Although the space agency will stress cutbacks in manned spaceflight in its interim operating report, this could change if the supplemental request is denied. The task of getting to the Moon before the end of the decade is still the agency's responsibility.

If the supplemental is not forthcoming, the agency very likely will start to use the shears on its unmanned spacecraft and research programs in an effort to dredge up funds for *Apollo*.

• **Fiscal '65 outlook**—The expected NASA request for a funding of $5.6 to $5.8 billion in the next fiscal year will contain no money for new projects of major proportions. Some of the programs which NASA would like to develop but which will be left out of the budget include the manned space station, *Voyager, Advanced Pioneer* and advanced Fire re-entry system.

The Lunar Logistic System using the LEM truck may come in for some small, disguised, funding to begin development of critical systems. The spacecraft, however, will not appear as a line item in the budget. This stems not only from the money squeeze, but is also because the LEM prime contractor, Grumman Aircraft Engineering Corp., will not have the capability to take on the job of modifying LEM for the mission until early or mid-1965.

Manned space flight programs, as in previous years, will get the lion's share of the budget. Estimates at this point are foggy because of the unknown fate of the supplemental requests, but it is expected that its research, development and operations budget will approach the $3.2-billion mark.

Development of the *Apollo* spacecraft and operational vehicles is ticketed for about $1.1 billion. Project *Gemini* will tail off slightly from its Fiscal '64 level, to $250 to $280 million.

Another big slice, about $900 million, will pay for the *Saturn V* booster, is still in the early development stages.

PROGRESS REPORT ON HYBRID ROCKET MOTOR DEVELOPMENT AT UTC

■ Hybrid rocket motors, which commonly use high-energy solid fuel and liquid oxidizers, offer the potential of very high performance coupled with simplified on-off capability and modulated thrust. Hybrid motors could be important for a variety of tasks ranging from large segmented booster engines — alone or in clusters — to tiny attitude control units for space vehicles and propulsion back-packs for spacemen.

■ Hybrid motors offer certain specific advantages: they have higher I_{sp} (specific impulse) than either solid propellant motors or current storable liquid rocket engines; only one oxidizer flow valve is involved, therefore hybrids can be built that are easier to handle than liquid engines — easier to throttle, start and stop, even in space; they come in smaller, less complicated packages than comparable liquid fuel engines, because more than half the "plumbing" is eliminated; and a hybrid engine will operate normally regardless of chamber pressure, initial grain temperature, or cracks, flaws or voids in the grain.

■ Because the hybrid's fuel is separated from its oxidizer, it is much more economical to produce and is safer to handle than propellants which already contain an oxidizer. Large hybrid grains can easily be segmented for transportation to assembly site. And clusters of hybrids could be "idled" at low throttle to permit pre-flight inspection prior to liftoff.

■ UTC has been interested in hybrid rocket motors since the company's formation — a long time on the aerospace clock. Over a year ago, UTC test-fired a 10,000-pound-thrust hybrid motor at its huge Development Center at Coyote, California. The success of this test spurred follow-up studies at UTC, which ranged from literally thousands of small-bore stability firings to prolonged (over 600 seconds) duration tests.

■ On company-funded programs, as well as under Navy, USAF and ARPA contracts, UTC has designed, built, and tested a variety of hybrid rocket motors. A year ago, state-of-the-art hybrids were plagued with uneven burning. Now smooth, stable combustion has been achieved.

■ A space-storable hybrid motor which UTC designed for upper-stage applications has demonstrated higher I_{sp} than any storable rocket propulsion device yet tested in the 1000-pound thrust range.

■ UTC's extensive research, development, and test facilities both at its Sunnyvale headquarters and at its sprawling Coyote Development Center are manned by widely-experienced scientists and management personnel. They have the finest modern equipment at their disposal, as well as the talent and resources of the entire Center. Moreover, the support of the parent company, United Aircraft, is a real asset to UTC.

■ Hybrid motors are not expected to replace either solid or liquid propellant rocket motors now in use. Advanced assignments that impose limitations beyond the design of current systems will determine the hybrid's future role. They form the natural bridge between UTC's activities in space-storable liquid propellant rocket engines and its solid propellant rocket motor program, which includes the role of prime contractor for the first stage of USAF Titan III C.

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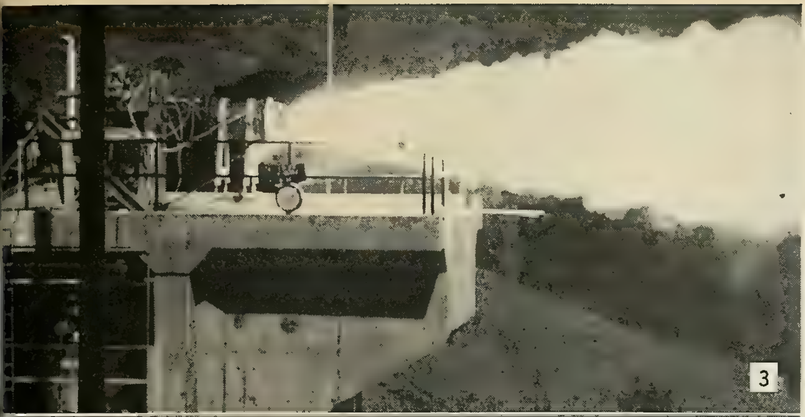

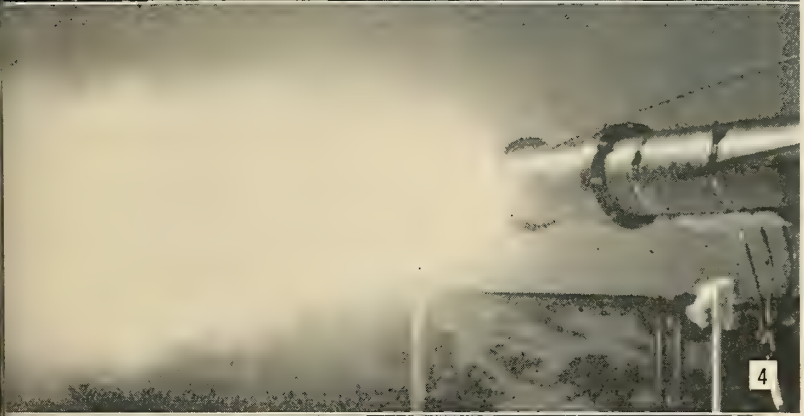

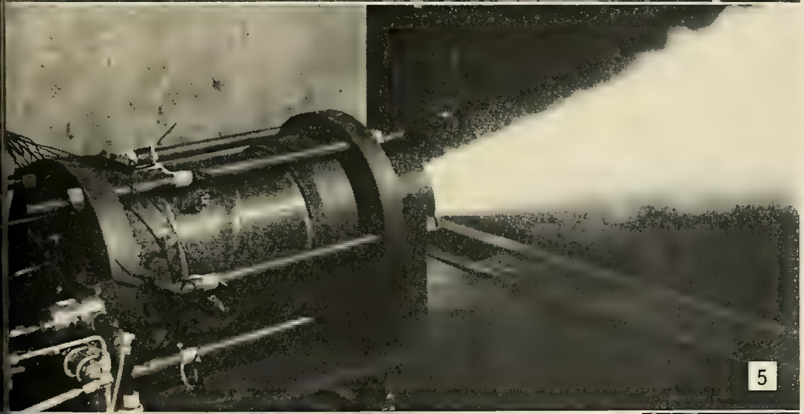

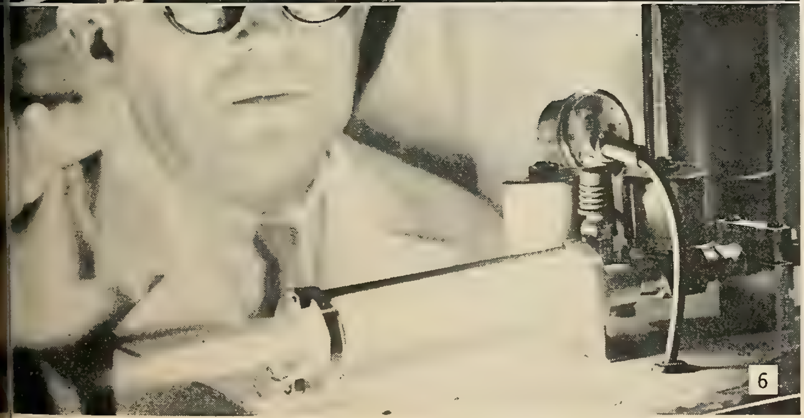

1. HYBRID FUEL DOGBONE is exposed to bare flame, yet will not burn. It will ignite hypergolically when oxidizer is applied. Because there is little danger of inadvertent ignition, processing and handling problems are greatly reduced for hybrid motor grains.

■

2. STEADY BURNING, shown in bottom photo, is possible now with UTC's advanced fuels. Top photo shows uneven burning which cost hybrids up to 25% of potential energy as recently as two years ago.

■

3. 10,000 - LB. - THRUST HYBRID rocket motor was fired at UTC's huge Development Center near Coyote, California, early in 1962. This fully successful firing culminated early research and gave powerful impetus to a continuing hybrid program at UTC.

■

4. VERY HIGH PERFORMANCE fuel and oxidizer provide this segmented 5″ hybrid rocket motor with over 800 lbs. of thrust in a recent test firing.

■

5. 12-INCH HYBRID MOTOR undergoes one of a series of firings in the 1,000-lb. thrust range. Numerous tests show that even major cracks in the surface of the grain have no effect at all on combustion because the hybrid's active combustion zone is away from the surface of the grain.

■

6. SMALL HYBRID TEST MOTOR is an off-the-shelf item at UTC. More than 10,000 firings without failure show its reliability.

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Procurement of F-1 and J-2 engines is included in the figure.

Funding for the *Saturn IB* booster —which will begin manned *Apollo* spacecraft flights in late 1966 under the current schedule—will jump from $68 million to about $150 million. *Saturn I* will be cut well below $100 million.

Development costs of the engines for the launch vehicle program will stay approximately at the Fiscal '64 level. This would call for $60 million for the 1.5-million-lb.-thrust F-1 engine and about $54 million for the 200,000-lb.-thrust liquid hydrogen J-2.

The size of M-1 funding will depend on the review of the program.

NASA estimates its requirements for backup systems for the *Apollo* spacecraft at $300 million in Fiscal '65. No decision has been made as to what systems will have parallel development, but those under consideration include fuel cells, the guidance and navigation system, reaction controls and components of the Lunar Excursion Module.

Construction requirements for manned space flight are estimated at $300 million, well below the Fiscal '64 request of $564 million.

The Manned Spacecraft Center and Marshall Space Flight Center will both get between $20 and $30 million. Over $100 million will be spent on launch complex 39 at the Merritt Island launch area at Cape Canaveral. The remaining funds would be used in the construction of the Mississippi Test Facility.

- **Future projects**—How soon NASA can begin development of some of the new projects in its shopping bag will depend upon its Fiscal '66 budget. In estimating requirements of $5.7 billion, officials indicated that this contained no room for new projects.

It is expected that Congress—during the 1964 election year—will again make significant reductions in the FY '65 budget. This would mean delaying some funding for the Moon program until FY 1966, making new projects even more unlikely.

NASA's one hope, at this point, is that once the election is over and Congress can cease to be so economy-minded, its budget request will receive more favorable treatment. This could provide enough new money so that some future projects could be started in FY '66 and '67.

Despite the lack of a decision on management of the space station project, NASA is proceeding with its own study program. It will announce shortly the award of a contract worth over $1 million to either Douglas Aircraft Co. or the Boeing Co. to continue studies of its six-man cylindrical *Manned Orbiting Laboratory*.

(For a breakdown of RD&O authorization by program, see p. 98.) ■

View Of The Project Management Building and News Auditorium at NASA's Manned Spacecraft Center, from A Nassau Bay Office Building

PRIME OFFICE SPACE
at the entrance to the
MANNED SPACECRAFT CENTER

The Nassau Bay Office Complex, now under construction directly across the street from the main entrance to NASA's Manned Spacecraft Center, at Houston, provides prime office space readily adaptable to your exact requirements. The complex will consist of 12 two-story buildings and one 12-story high rise, and is designed to blend with the overall atmosphere of Nassau Bay. This totally new residential and commercial development, located in the heart of the NASA area, offers convenience features that rival any metropolitan city. Wilbur Clark's Crest Hotel and the Sheraton Motor Inn are next door, a complete community shopping center, over 1000 new and modern apartment units and hundreds of beautiful homes are within three minutes driving time of this perfect location. In addition there are churches, marinas, clubs, fine restaurants, parks and recreation areas, all in a setting of lush natural beauty.

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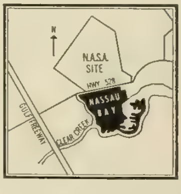

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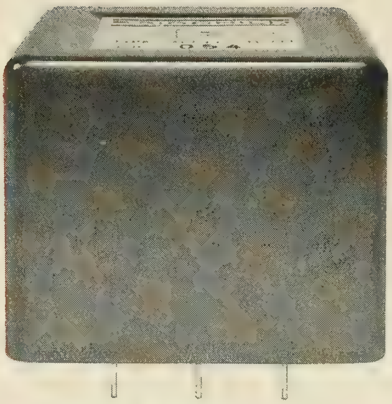
AIRCHILD ANNOUNCES

F-31963-A

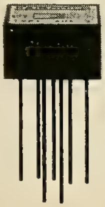
LOW DRIFT AMPLIFIER: 1 μV/°C WITH NO CHOPPER

FAIRCHILD ADF-1

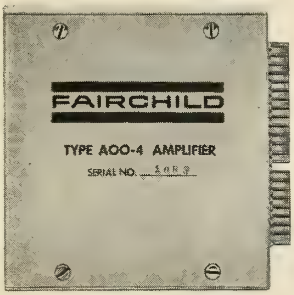


The solid state ADF-1 differential input and output amplifier is the latest addition to a complete new Fairchild line. It offers extremely high stability without the use of a chopper. Other Fairchild differential and operational amplifiers are shown below. Write for data sheets.

Drift=1μV/°C. from 0°C. to +60°C.
Noise less than 5μV/p-p
Common mode rejection=90 db @ 60 cps;
100 db @ DC
Fixed gain=1000
Size=$1\frac{11}{32}'' \times 1\frac{11}{32}'' \times 1\frac{3}{8}''$
Output=20 V/p-p @ 1 mA
Pre-aged—100 hour operational test



Differential Amplifier—ADO-3 Differential input single ended output • Gain=20,000 or greater • Gain Bandwidth Product=1.6 megacycle • Output=±10V @ 1 mA • Drift less than ±4 mV from −25°C to +85°C • Size=$1\frac{1}{8} \times 1\frac{1}{8} \times \frac{5}{8}''$ • Lead Spacing —0.1 inch grids.



Operational Amplifier—AOO-4 Solid state, chopper stabilized • DC gain over 5×10^6 • Gain Bandwidth Product = 2 megacycles • Output = ±20V @ 2 mA; ±10V @ 7 mA • Drift less than 10μV/°C from −20°C to +85°C • Plug-in case 4 x 5 x 1″ • P. C. edge connector • No chopper drive required.

Operational Amplifier—AOO-6 Photo chopper stabilized • DC gain over 10^7 • Gain Bandwidth Product=1 megacycle • Output=±26V @ 5 mA • Drift less than 0.5μV°/C from 0°C to +55°C • Long term drift 1μV per week • Plug-in case, precision connector; $1\frac{1}{2} \times 3 \times 6''$ • No chopper drive required.

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STL NEW PROPULSION OPPORTUNITIES

In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

Requirements include a degree in engineering or science with appropriate experience.

LIQUID ENGINE DESIGN, DEVELOPMENT AND TESTING

Experience in the design, development or testing of liquid propellant propulsion systems, rocket engines, feed system components, thrust chambers, injectors and thrust vector controls.

ROCKET ENGINE TEST STAND INSTRUMENTATION AND CONTROLS

Experience in the design, installation, operation or maintenance of liquid rocket engine test stand data acquisition (analog and digital) and control systems.

RESEARCH AND ANALYSIS

Experience in heat transfer, hydraulics, gas dynamics, combustion, ablative materials, and data processing and analysis.

For interview in your area in the near future, act NOW! Forward your resume to STL Professional Placement, Department MR-11, One Space Park, Redondo Beach, California. TRW is an equal opportunity employer.

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RD&O AUTHORIZATION BY PROGRAM

(dollars in millions)

PROGRAM	FY 1963	AUTHORIZED FY 1964
Tracking and Data Acquisition	$ 135.0	$ 218.2
Meteorological Satellites	42.7	63.7
Communications Satellites	35.3	42.2
Advanced Applications Satellites	.6	.0
Technology Utilization (Industrial Applications)	2.3	3.5
Electrical Propulsion	....	....
Nuclear Electric Systems	39.3	68.8
Nuclear Rockets	69.6	91.2
Space Power	8.4	16.5
Space Vehicle Systems	37.6	53.5
Electronics Systems	17.4	30.4
Aeronautics	15.8	16.2
Human Factor Systems	9.9	13.2
Solid Propulsion	....	....
Liquid Propulsion	....	....
Chemical Propulsion	14.4	24.5
Research Grants and Contracts	....	....
Sustaining University Programs	30.6	40.0
Scout Development	....	....
Delta Development	....	....
Launch Vehicle Development	100.3	127.7
Lunar and Planetary Exploration	173.2	274.4
Geophysics and Astronomy	113.6	194.4
Life Sciences	....	....
Manned Space Science	....	.6
Bioscience	13.8	21.2
Vehicle Procurement (OSS)	116.7	....
Launch Vehicle Procurement (OMSF)	152.4	....
Manned Spacecraft Systems	570.3	1,496.6
Manned Launch Vehicle and Propulsion Systems	756.4	1,147.5
Manned Space Flight Integration and Checkout, Reliability	34.5	125.0
Aerospace Medicine	5.8	11.0
Manned Space Flight Systems Engineering	21.2	37.0
Operation	439.4	518.2
Other	....	....
TOTAL	**$2,974.6**	**$4,637.8**
Appropriation Transfers and Adjustments	76.7	....
Original Appropriation	$2,897.9	$4,637.8

CONSTRUCTION OF FACILITIES

LOCATION	FY 1963	AUTHORIZED FY 1964
Ames Research Center	14.20	11.0
Launch Operations Center	304.03	285.0
Flight Research Center	1.70	1.2
Goddard Space Flight Center	21.47	17.0
Jet Propulsion Laboratory	10.00	3.0
Langley Research Center	9.84	8.2
Lewis Research Center	44.81	18.6
Manned Spacecraft Center	23.63	35.1
Marshall Space Flight Center	40.58	29.0
Michoud Plant	28.56	8.7
Mississippi Test Facility	73.41	100.2
Nuclear Rocket Development Station	17.47	15.7
Wallops Station	4.16	.5
Pacific Missile Range	.....	....
Western Operations Office	.....	....
Various Locations	138.09	160.0
Electronics Research Center	.....	5.0
Facility Planning and Design	13.35	20.0
TOTAL	$745.30	$713.1
Appropriation Transfers and Adjustments	30.94	....
Appropriation Total	$776.24	$713.1

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Natural Codes, Continuous Outputs Without Code Conversion, Gears, Brushes, or Reference Rotor

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Typical DIGISECs* provide 19-digit resolution and accuracy in a 5-inch diameter case (illustrated above with transistorized translator and display unit), 18-digits in a 3½-inch case, and 20-digits in a 10-inch case. ☐ Parallel, on-the-fly, direct digital readout in any natural code including binary and decimal. ☐ Incremental readout for system simplification or precision tachometer applications. ☐ Analog outputs also available for high precision servos—equivalent to 32,768 pole resolver (19-digit model). ☐ Low inertia, non-contacting encoder disc, low friction bearings. ☐ Simple associated circuitry — high reliability.

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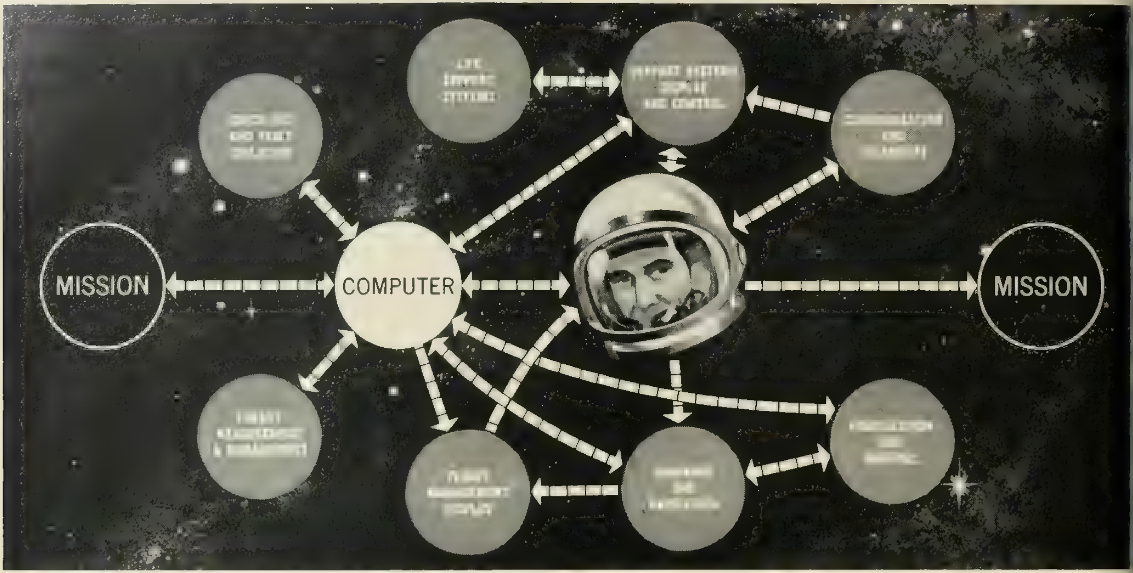
How can Pilot/Managers



MAN-MANAGEABLE SYSTEMS INTEGRATION for an aerospace vehicle produces a flexible man/machine team for managing a flight successfully. This single-system development for wide application brings together Honeywell's full-spectrum capabilities and experience in a variety of subsystem areas. Honeywell has proven its management experience in each of these areas (and related areas) to provide man-manageable systems.

Sustenance for spacemen: What are minimums?

Since the volume and weight of supplies to sustain a five or six-man crew in a space station for a year would reach unwieldy proportions, Honeywell is studying the problem of biologistic tasks for rendezvous vehicles.

In constructing a realistic mission for a six-man crew in a space station that requires resupply every 30 days for a period of two to three years, the Incremental Life Support Operations (ILSO) must consider many factors: oxygen provision, removal of carbon dioxide, water provisioning and recovery, and waste management. In addition, the amount of room and living environment of the station and how ILSO affects them are also being considered.

For example, 1,200 pounds of water (including two-week emergency rations) will be required at launch to maintain the crew for 30 days—if metabolic waters of respiration and perspiration are reclaimed. However, before any conclusions can be reached on water supply versus reclamation, Honeywell scientists and human factors engineers are considering both the psychological and physiological factors and reclamation equipment required. The study is one of a series that Honeywell is conducting on man-machine relationships, how to support man in space, and the adaptability of the human body to space station conditions.

Some of these current Honeywell-supported studies include the investigation and analysis of respiratory and circulatory physiology aimed at understanding the causes and prevention of oxygen toxicity and contamination.

Honeywell considers life support a major subsystem in an aerospace vehicle. The company's staff of highly trained human factors engineers are thoroughly familiar with the psychological and physiological aspects of operating and living in space stations and aerospace vehicles. These efforts are extending Honeywell's overall system capability to assure that Honeywell aerospace systems are compatible with man and will support his mission.

Technical paper on "Biologistic Tasks for Rendezvous Vehicles" is yours free of charge. Write Honeywell, Dept. 671A, 2600 Ridgway Road, Minneapolis, Minn. 55440.

ADVANTAGES of Honeywell's Man-Manageable System

1. Man's capabilities are used to t fullest extent in an optimized ma machine relationship. Man-manag able controls extend man's capab ities in accomplishing the missio

2. Tradeoffs among subsystems ar man's capabilities are determin from a mission standpoint.

3. Test and maintenance can introduced so that checks can made upon subsystem performan and corrective maintenance of co ponents, modules and subsyste can be made in flight.

4. Circuits and components a standardized, subsystems are ma related and optimum redundan or back-up is achieved.

5. Operational reliability and i creased mission flexibility are a tained. Fewer on-board subsyste and back-up units are needed.

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be integrated into future aerospace missions?

Automatic systems must be designed to bring man's management capabilities into play

Completely automated systems, *vhen performing their functions eliably,* are such that it may be ossible for man to complete an erospace mission and return safely —without ever making a single ecision affecting the mission.

However, the inevitability of ystem performance deviation—as vell as the additional weight of ubsystems to do tasks that are imple for man—require that future ehicle systems provide for man to lay an active role. Consequently, Ioneywell systems are designed so hat *man can manage the mission* hroughout all its phases. This deign approach results in what we all a "man-manageable system"— ne that has the flexibility to be dapted to changing conditions in he course of a mission.

Exactly what is a man-manageble system? It is one that puts nan in complete charge of the mision, able to allocate tasks and ubtasks to the various subsystems —or to himself—during the flight. For example, during a space ferry nission the astronaut may want his ystem to automatically handle both uidance computation and control. Dr he may only want the system to isplay solutions to alternative uidance problems which he poses. *But the decisions are his.* A mannanageable system does not take ver the decision-making and ction-initiating functions of man see illustration at left).

Of course, man can't possibly lirect all subtasks constantly durng a space flight. Limits of space nd time do not allow having a eparate display for every information element. In fact, displays must e integrated and compatible with he astronaut's capabilities and with he system. From these displays nan must comprehend the information and be able to act upon it uickly—and in some cases reflexvely.

Information comes to the man rom a computer which collects, ssimilates and processes the vast mount of data provided by the arious subsystems. A balanced allocation of tasks and information between man and the computer produces a flexible team for managing the flight and accomplishing the mission.

Such a man-manageable system is made up of interdependent subsystems that may be unified upon command. For instance, the guidance, control, stabilization, energy control and life support subsystems must be planned and built with an understanding of both the subsystem's peculiarities and its role in the man-managed mission. As a result, man and all other subsystems are properly interfaced so they function integrally to perform the required operations. Together they form a closed loop system.

This systems philosophy is a basic element in producing man-manageable systems. System management goals can then be translated into a plan of task sequences and task allocations, which results in a compatible group of major subsystems that can be planned down to the smallest engineering and production detail.

Due to the range of technologies required, from mission analysis through production, a man-manageable system requires that a contractor be highly experienced and knowledgeable in each subsystem area. Through active participation in every type of U.S. military and space program, Honeywell has developed a high percentage of total resources required to fulfill the role of man-manageable systems integrator.

We invite management level discussions on Honeywell's unique capabilities in producing man-manageable systems and their integration and application to next generation aerospace systems. Write Honeywell, Dept. 671A, 2600 Ridgway Road, Minneapolis 40, Minn.

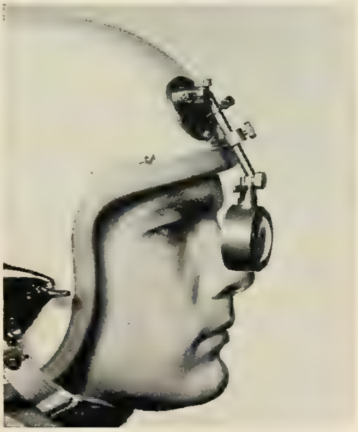
Honeywell investigates high-speed sighting

Tactical air warfare missions of the future may be flown at high speeds and as low as 50 feet above the ground.

A new concept in quick-reaction bore-sighting will permit pilots of the future to track and fire on targets within seconds after locating them.

Honeywell's concept requires the pilot on a tactical air warfare mission to merely look at the target through an eyepiece mounted on his helmet and press a "fire" button. Sensing devices mounted in the helmet will automatically locate the target with reference to the aircraft and feed the information into a centralized computer.

The computer, by knowing the aircraft's attitude, position and speed, computes the required trajectory and fires the missile at the optimum time.



EVALUATION MODEL of helmet-mounted target sighting device is used in human factors studies at Honeywell probing search behavior and predicting the performance level of the human eye while a pilot is flying a low-altitude tactical mission.

ENGINEERS AND SCIENTISTS: Explore new professional opportunities. Write Mr. Fred A. Laing, Honeywell, Minneapolis, Minnesota 55408. An Equal Opportunity Employer.

Honeywell

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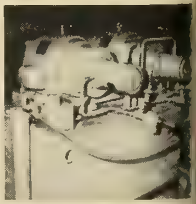
Hydraulic power package lifts the giant Saturn gantry complex before blastoff

October 27, 1961 (10:06 A.M. EST) at Cape Canaveral's Complex 34 marked the successful launching of the first NASA Saturn (C-1) space vehicle. A Denison hydraulic power system played a key role in the ground support phase of the Saturn launching. The unit (two were designed and built by Denison in the near-record short period specified by NASA) pulls the locking pins and raises the huge gantry tower complex onto trucks prior to firing.

Each power unit consists of a 110-gallon, stainless steel JIC reservoir with stainless steel tubing and fittings. And each unit incorporates two 5000 psi Denison Series 600 constant volume axial piston hydraulic pumps plus control console panel.



Your nearby Denison hydraulics specialist will welcome discussing ground support equipment fluid power applications with you at any time. He has complete data on our full line of hydraulic pumps, motors, valves and controls for GSE systems up to 5000 psi. To get in touch with hir —and for your free copy of the new 72-page Deniso Hydraulic Power Catalog—write, wire or phone us now

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WALTER L. LINGLE, deputy associate administrator.

ERNEST H. BRACKETT, director of procurement.

NASA /procurement

Agency Renegotiating to Incentives

Regulations being consolidated into single volume; Pentagon evaluation system to be applied; source-selection manual to be published

NOT ONLY IS NASA continuing s trend toward issuing more incentive ontracts, but it is now attempting to onvert to incentives certain contracts riginally issued under more convenonal terms.

At least two such standing contracts ave been successfully renegotiated, and ree more are being considered for onversion.

Other recent procurement developents at NASA include:

—All space agency procurement egulations are being consolidated into ne volume to be available to conactors in January under the title, NASA Procurement Regulations."

—A decision has been made to pply the Defense Dept.'s contractor erformance evaluation system to future rge research and development prorams.

—A manual explaining NASA's ource-selection philosophy and proedure has been drafted, is under review, and will be published in the near future.

—A central pricing office, reporting to the Deputy Associate Administrator for Industrial Affairs, has been established to serve as a focal point for determining pricing policy.

—A survey division has been formed to inspect procurement problems in the field purchasing offices and periodically report on them at headquarters.

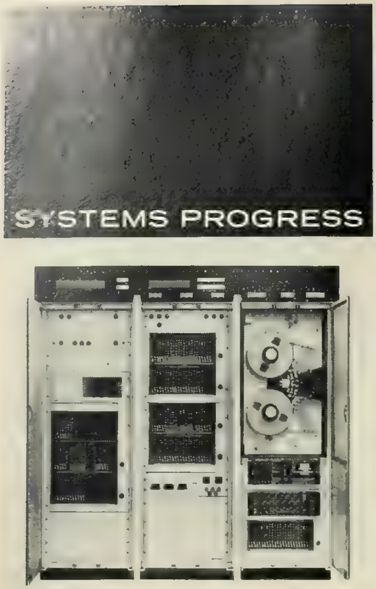
—Use of "postal card" reports, whereby prime contractors report to NASA on subcontracts issued for more than $10,000, has been expanded.

With some 92% of its expected $5.2-billion FY '64 appropriation destined for industrial procurement, NASA is also attempting to expand the number of concerns sharing in space program expenditures. Postal-card reports from 12 prime contractors located in eight states indicate that these larger firms have issued some 4,000-5,000 subcontracts, valued at 40% of the prime total, with 1,284 firms in 40 states.

To keep communications channels open between industry and top-level NASA officials on contracting matters, a new Office of Industrial Affairs, headed by a deputy associate administrator, has been created. This represents an effort on the part of NASA to accommodate industry's expressed desire to make known to the space agency all its capabilities and facilities. NASA's Director of Procurement now reports to the Deputy Associate Administrator for Industrial Affairs.

- **Swing to incentives**—According to Deputy Associate Administrator Walter L. Lingle, who organized the Office of Industrial Affairs, "it is our policy now to look at every major contract to see whether incentives can sensibly be included."

By using incentives, NASA is hoping to avoid at least some of the bad points of the earlier conventional con-



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MicroSADIC Digital Data systems are the efficient, economical link between instrumentation and digital computers—automatically handling data acquisition, conversion, and recording in computer-ready format.

Because of CSC's modern design techniques, you can order a custom MicroSADIC system assembled from field-proven modules to fit your application requirements. Every system is:

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tracting to discourage overbidding on performance and delivery and underbidding on cost. Better pre-planning and program definition usually are prerequisites to even competing for an incentive contract. Also, NASA feels that incentives spur contractor competition.

Despite the fact that many NASA programs do not lend themselves to incentive contracting, the agency and industry are mutually attracted by the system's superior economics and fewer management constraints.

Certain general types of incentive contracts, custom-negotiated for each award, have been found applicable to some NASA programs:

—Cost-plus-incentive-fee contracts are based on a target cost, set by NASA and agreed to by the contractor. The fee awarded the contractor depends upon his success in remaining below the target cost and, usually, the technical performance of his product.

—A fixed-price-incentive-fee contract is basically a cost-plus-incentive-fee, but in the event that a predetermined price ceiling is exceeded the contractor must pay a specified percentage of the cost overrun. This type of contract never has a performance target without also including a cost target.

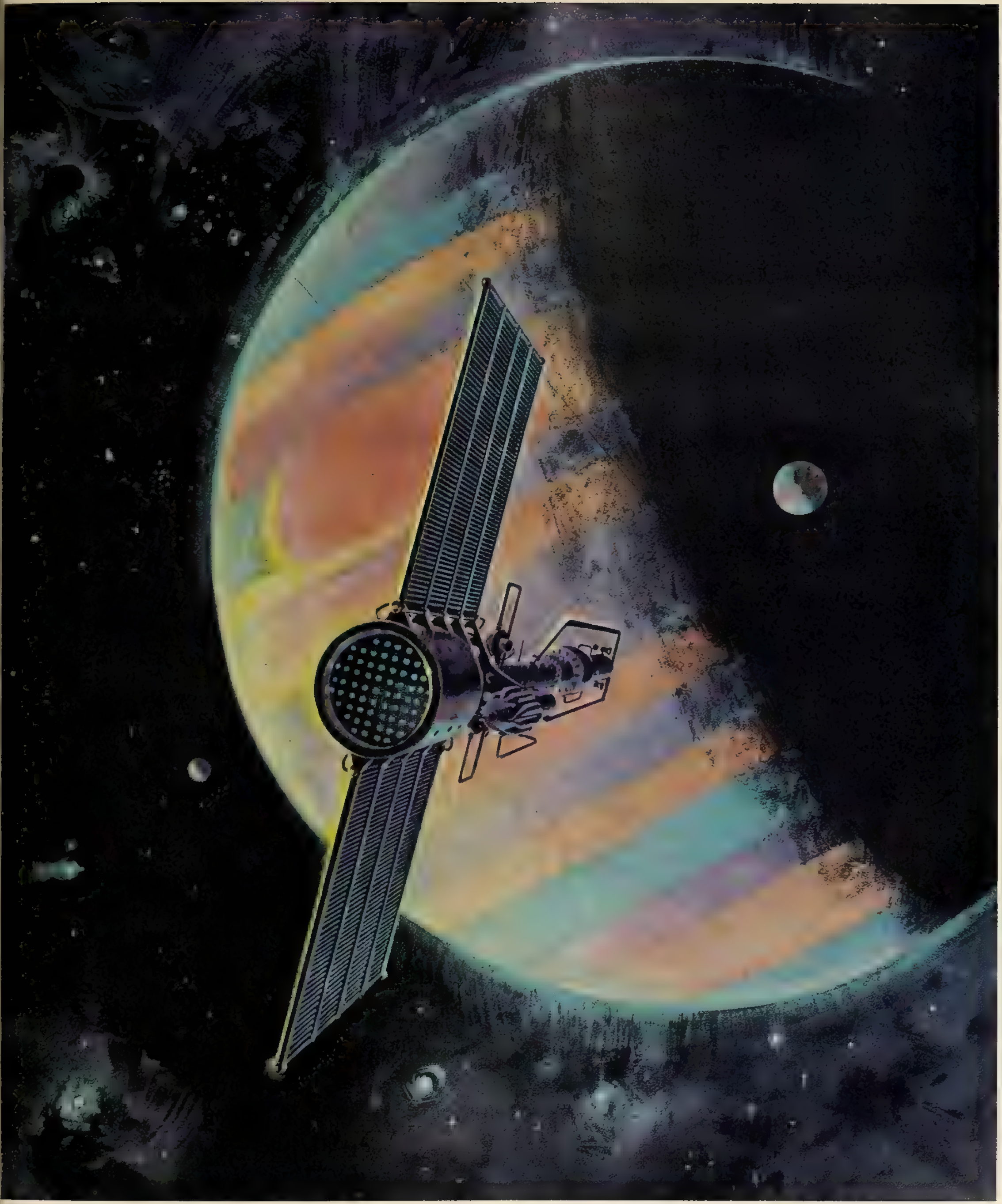
—The award-fee incentive contract is unique to the space agency and may prove useful where other forms fail. In this type of contract, there is no target cost or formula for determining higher or lower fee—a useful feature in far-out R&D work where there is little or no precedent for determining cost or performance targets. A high-level NASA board makes these incentive awards, basing its selection upon reports from project managers concerning contractors' adherence to initially-agreed-to criteria—such as cost control, program management, lack of engineering failures and schedule milestones. Reports from contractors also will be accepted and taken into consideration by the board.

The first award-fee contract, with

INCENTIVE CONTRACTS CURRENTLY IN PROGRESS

Item Desc.	Type Contract	Contractor	Contract Date	Estimated Completion Date	Total Obligated	Target cost	Target Fee
T/M and command ground station	FPIF	Hughes	6/12/62	8/31/63	$ 584,179	$ 521,588	$ 51,159
Aerobee 350 rocket sys.	FPIF	Aerojet-General	6/30/62	4/64	$ 1,065,483	$ 965,247	$ 100,326
Thin film s/c memory	CPIF	Sperry Rand, Univac	3/14/63	3/14/64	$ 211,650	$ 196,950	$ 14,700
Orbiting Geophys. Observ.	CPIF (conv)	Space Tech. Labs	9/63	Early '65	$51,330,000	$49,500,000	$1,830,000
Orbiting Astro. Observatory	CPIF (conv)	Grumman	1/8/63	Early '65	$68,062,958	$65,000,000	$3,000,000
Services for Mercury Network	CPIF	Bendix Field Engr.	1/8/63	12/31/64 with option to 12/31/65	$ 5,133,810	$10,535,010	$ 300,000
Nimbus prototype controls subsystem	AF (conv.)	GE	2/1/61	Early '64	$ 8,509,245	$ 8,361,369	$ 147,876
23 Scout Vehicles	FPIF (conv)	LTV	5/10/63	December 1964	$ 9,405,000	$ 8,550,000	$ 855,000
Horizon Sensor Systems	FPIF	Martin	5/21/61	11/10/62*	$ 111,039	$ 103,041	$ 7,998
NERVA	AF	Aerojet	7/10/61	9/30/66	$60,798,220	$56,745,733	$2,890,000
POGO Agena Mission	CPIF	Lockheed	7/1/63	6/30/65	$ 800,000	$ 2,477,500	$ 182,750
Study Astronomical Phenomena	CPIF	Lockheed	12/17/62	1/15/65	$ 2,950,000	$ 4,250,000	$ 313,000
Test of Saturn grnd. Support Com.	CPIF	Chrysler	4/12/62	9/30/63**	$ 581,357	$ 500,000	$ 37,900
Crawler-Transporters	CPIF	Marion Corp.	3/25/63	6/1/65	$ 8,998,763	$ 8,332,188	$ 666,575
14 Delta Vehicles	CPIF	Douglas	2/7/63	11/64	$ 8,451,464	$13,450,000	$ 940,000

* Redetermination not complete.
** Contract complete pending publication of final report.



Power to probe the planets will come from SNAP-50/SPUR, a compact nuclear reactor being developed for the Atomic Energy Commission by Pratt & Whitney Aircraft. This lightweight system will produce several hundred kilowatts of electricity to power the electrical space engines and advanced military satellites of the early 1970s. Pratt & Whitney Aircraft provides leadership in power for many applications, in and out of this world.

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A

the Bendix Corp. for maintenance and operation of *Mercury* tracking stations, was encouraging. Part of the contract for the *Lunar Orbiter* may be awarded under award-fee terms.

- **$\$1/4$ billion on books**—NASA currently has 17 active incentive contracts with 13 firms on its books, the target prices (target cost plus target fee) of which total $256.5 million. Values of these range from $111,039 (to Martin Marietta Corp. for horizon sensor systems) to $68 million (to Grumman Aircraft Engineering Corp. for the *Orbiting Astronomical Observatory* spacecraft).

NASA has converted two standing contracts into incentive awards. Ling-Temco-Vought received a fixed-price-incentive-fee follow-on contract for 23 *Scout* research vehicles last May. A renegotiated contract with the Marion Power Shovel Co. will put production of *Saturn* crawler-transporters on an incentive basis, including a penalty for late delivery.

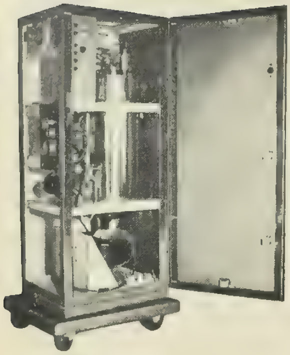
An additional $24.3 million in cost-plus-fixed-fee and fixed-price contracts with three firms is presently being renegotiated to include incentive features. NASA Director of Procurement Ernest W. Brackett told MISSILES AND ROCKETS that more contracts already in progress will be reviewed with an eye to converting "as many as we can" to incentives.

- **Performance evaluation**—To provide industry with the incentive for optimum performance on that majority of NASA contracts that will remain of a conventional type, the space agency has decided to adopt the Defense Dept.'s contractor performance evaluation system. This is to be applied to R&D contracts valued at more than $5 million for one year or at more than $20 million total.

The purpose of performance evaluation is to provide industry a long-term incentive for good work by creating within NASA a "memory" of contractors' performances on individual contracts. Periodic reports are filed during the course of contracts by Government project managers, who base their assessments on the accomplishment of certain cost, schedule and technical criteria. These reports are stored in a central "data bank," which may be drawn upon for future source-selection information.

NASA plans to establish a contractor performance evaluation group that will consider such information in connection with future contract awards.

The space agency will continue to rely heavily on DOD contract administrators. The Defense Dept. is well organized to provide such assistance, and NASA has been satisfied with DOD cooperation in the past. ■



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hus today's chemist is also an electronics expert. Today's mathematician is at home in space flight technology. oday's design engineer can talk propulsion with rocket men, life sciences with biophysicists.

rom the resulting intellectual ferment—the intermingling of ideas—are coming achievements such as the world as never seen. Among them: the three-man Apollo module—an aerospace project being built by NAA's Space & nformation Systems Division to carry America's astronauts to the moon and return them to earth. Such advances re possible only because the men seeking them are not die-cast, their talents not hardened in a single mold. or these are the flexible men.

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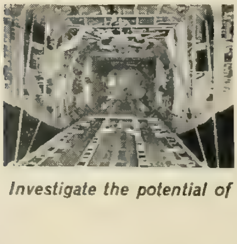

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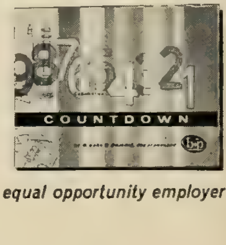

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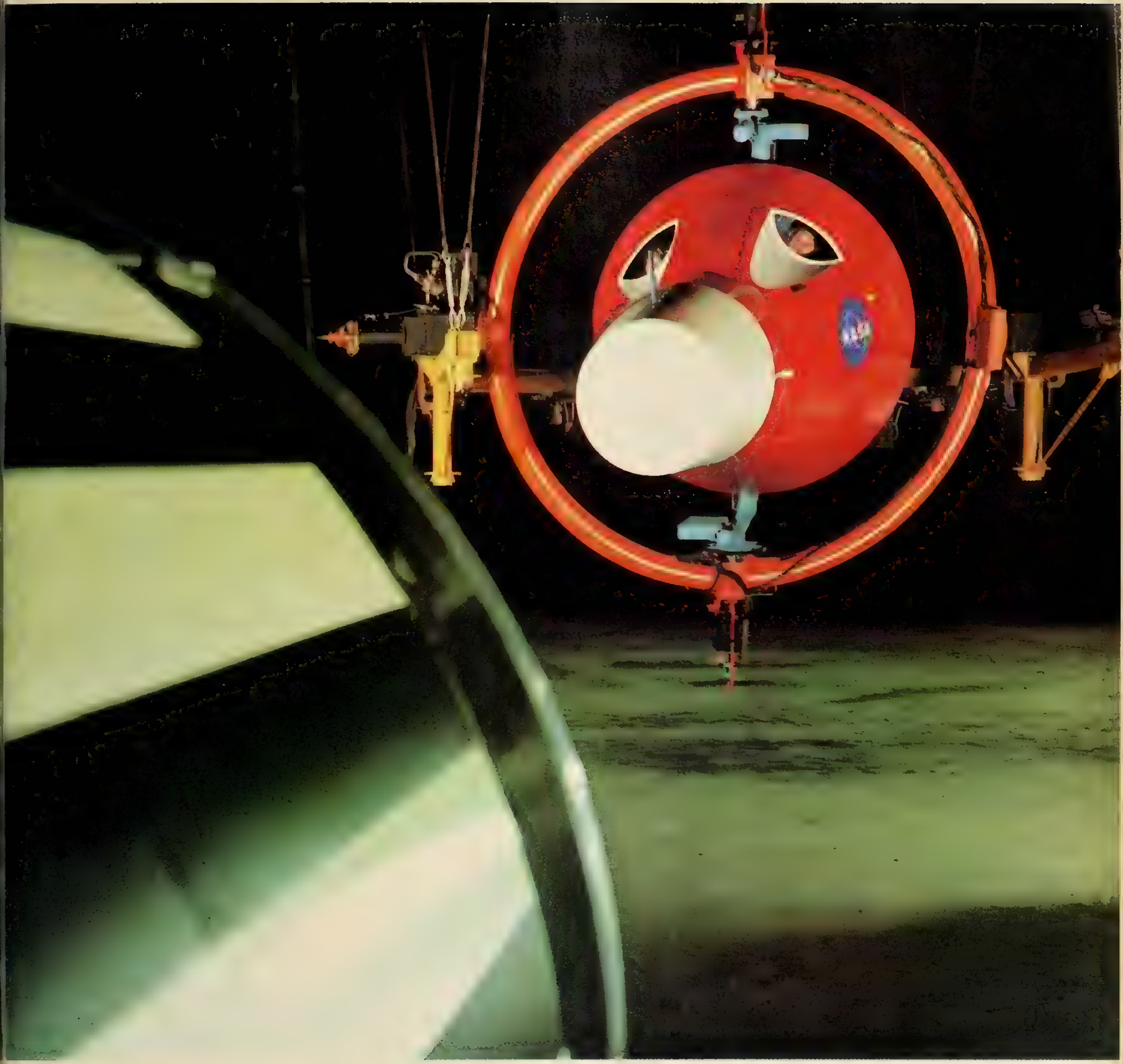

THIRD ANNUAL NASA ISSUE

art III

DVANCED PROGRAMS

NASA LAUNCH SCHEDULE TO THE MOON

UNMANNED SPACEFLIGHT PROGRAMS

First Quarter, 1964

Spacecraft/Mission	Site	Vehicle
Ranger VI	AMR	Atlas-Agena
S-66A	PMR	Scout
UK-2	W.I.	Scout
S-66A Backup	PMR	Scout 18
Rigidized Passive Comm. Satellite	PMR	Thor-Agena 2
Air Density/Injun	PMR	Scout 19
IMP-B	AMR	Delta 26
FIRE I	AMR	Atlas-X-259
International Satellite S-52A	W.I.	Scout 20
Ranger RA-7	AMR	Atlas-Agena 9
Relay A-19	AMR	Delta 27
Nimbus A-4 (Meteorology)	PMR	Thor-Agena 3
Vehicle Test	AMR	Centaur 4

Second Quarter, 1964

Spacecraft/Mission	Site	Vehicle
Launch Vehicle Attitude Control Test	WSR	Little Joe II-A
Ranger RA-8	AMR	Atlas-Agena 10
OGO-A	AMR	Atlas-Agena 11
Vehicle Test/Surveyor Dyn. Model	AMR	Centaur 5
S-3C	AMR	Delta 28
IMP-C	AMR	Delta 30

Third Quarter, 1964

Spacecraft/Mission	Site	Vehicle
Ranger RA-9	AMR	Atlas-Agena 12
OSO-C	AMR	Delta 31
Vehicle Test/Surveyor Dyn. Model	AMR	Centaur 6
OGO-C	PMR	Thor-Agena 5

Fourth Quarter, 1964

Spacecraft/Mission	Site	Vehicle
Surveyor Test	AMR	Centaur 7
Vehicle Test/Meteoroid Experiment	AMR	Sat. I R&D SA-8
Mariner C MC-1	AMR	Atlas-Agena 16
Mariner C MC-2	AMR	Atlas-Agena 17
Vehicle Test	AMR	Centaur 8

Calendar 1965

Spacecraft/Mission	Site	Vehicle
Surveyor Test	AMR	Centaur 9
Surveyor Test	AMR	Centaur 10
Vehicle Test	AMR	Centaur 11
Pioneer A	AMR	Delta 32
Surveyor Test	AMR	Centaur 12
OSO-D	AMR	Delta 33
Surveyor Operational	AMR	Centaur 13
Pioneer B	AMR	Delta 34
Surveyor Operational	AMR	Centaur 14
Surveyor Operational	AMR	Centaur 15
Pioneer C	AMR	Delta 35

UNDER STUDY

Spacecraft/Mission	Site	Vehicle
Ranger RA-10	AMR	Atlas-Agena 1
Ranger RA-11	AMR	Atlas-Agena 1
Ranger RA-12	AMR	Atlas-Agena 1
Ranger RA-13	AMR	Atlas-Agena 1
OGO-B	AMR	Atlas-Agena 1
Ranger RA-14	AMR	Atlas-Agena 2
OGO-E	AMR	Atlas-Agena 2
OGO-D	PMR	Thor-Agena 8
OGO-F	PMR	Thor-Agena 11
SERT-1A Electrical Engine	W.I.	Scout 14
SERT-1B Electrical Engine	W.I.	Scout 21

pollo Boilerplate Abort	WSR	Little Joe II-2
pollo Boilerplate Abort	WSR	Little Joe II-3
AO-A	AMR	Atlas-Agena 20
AO-B	AMR	Atlas-Agena 22
yncom A-27	AMR	Delta 24
-55C	W.I.	Scout 22
RE 2	AMR	Atlas-X-259
-55D	W.I.	Scout 23
e-entry 4	W.I.	Scout 17

MANNED SPACEFLIGHT PROGRAMS

First Quarter, 1964

Gemini unmanned orbital mission tests launch vehicle/acecraft integrity.

Astronauts begin training at MSC for long Gemini flights nd docking with another spacecraft while in orbit.

Second Quarter, 1964

Sixth Saturn I flight launches Apollo Boilerplate.

One man-rated Gemini spacecraft and one Titan II rocket rive every three months at MSC's Cape Canaveral angars.

Air Force completes Cape Canaveral control center to rect two rocket launches at the same time; center also can ack on orbiting space ship.

Backup Gemini unmanned orbital flight.

Little Joe II flight launches Apollo escape system and hicle attitude control test.

Little Joe II launch in test of Apollo abort system with pollo Boilerplate.

Third Quarter, 1964

"Mechanical Man" flies Gemini on suborbital test flights.

Houston's Mission Control Center complete; Clear Lake nter can track two space flights at the same time; will be sted on Gemini astronauts controlled from Cape Canav-al.

Saturn 9 launches vehicle test/meteoroid experiment.

Fourth Quarter, 1964

MSC begins receiving one man-rated Apollo Moon ship ery three months at Houston and Cape Canaveral.

Astronauts fly first Gemini spacecraft for three to five bits to test new equipment (could slip into early 1965).

Saturn 8 launches vehicle test/meteoroid experiment.

Saturn 10 launch for Apollo vehicle test.

First Quarter, 1965

Little Joe II launch tests Apollo spacecraft abort.

Astronauts orbit second Gemini for one week, including ace rendezvous with instrument package fired from space-aft.

Second Quarter, 1965

Houston Mission Control Center directs third Gemini ght, a stay-in-space of 10 to 14 days.

First Saturn I rocket leaves Michoud rocket plant in New rleans.

First Apollo spacecraft enters vacuum chambers at MSC-ear Lake for testing against cold and airless space hazards. ace suit testing begins.

Third Quarter, 1965

First "high bay" completed at Cape Canaveral to test upright assembly of 350-ft. Saturn V Moon rocket.

Third astronaut team flies Gemini in attempt to rendezvous and dock with an Agena rocket in space.

Fourth Quarter, 1965

Astronauts fly fifth Gemini mission.

First Quarter, 1966

Unmanned Saturn I-B rocket makes first test flight.

Astronauts make sixth Gemini flight.

Second Quarter, 1966

Launching pad for Saturn V Moon rocket completed at Merritt Island launch area, Cape Canaveral.

Astronauts make seventh Gemini flight; pair may make first attempt at land recovery.

Third Quarter, 1966

Second launching pad for Saturn V Moon rocket completed at Cape Canaveral.

Fourth Quarter, 1966

Saturn I-B rocket, capable of orbiting complete Apollo Moon ship, makes fourth and last unmanned test flight.

Ninth and possibly last Gemini tests rendezvous in space.

First Saturn I-B carries complete Apollo, including Moon "bug" or Lunar Excursion Module (LEM) around Earth.

First Quarter, 1967

First test flight of Saturn V rocket.

Astronauts fly second complete Apollo Moonship around Earth; flight tests equipment operation aboard LEM.

Second Quarter, 1967

Second unmanned Saturn V rocket fired.

Apollo astronauts practice Earth-orbiting rendezvous between LEM and Apollo "mother ship."

Third Quarter, 1967

Third Saturn V Moon rocket makes unmanned test.

Astronauts fly complete Apollo Moon ship in more docking tests.

Sixth Saturn I-B fires Apollo astronauts on practice flight near Earth.

Fourth Quarter, 1967

Fourth Saturn V fired in unmanned test.

Fifth Saturn V makes unmanned flight.

Apollo Moon ship crewmen fly seventh Earth training mission on Saturn I-B.

Calendar 1968

MSC prepares emergency supplies, shelters and spare space ship for landing on the Moon.

Sixth and final unmanned flight of Saturn V Moon rocket, once scheduled for last quarter of 1967.

Apollo astronauts make eighth and perhaps last training flight around Earth before flights around Moon.

Seventh Saturn V launches Apollo astronauts on photographic and observation flight around Moon.

Calendar 1969

Astronauts fly second reconnaissance mission to vicinity of Moon.

Earliest estimated date for American astronauts to attempt landing on surface of the Moon.

(NASA officially plans to make both flights in 1968, but slippage into 1969 is likely.)

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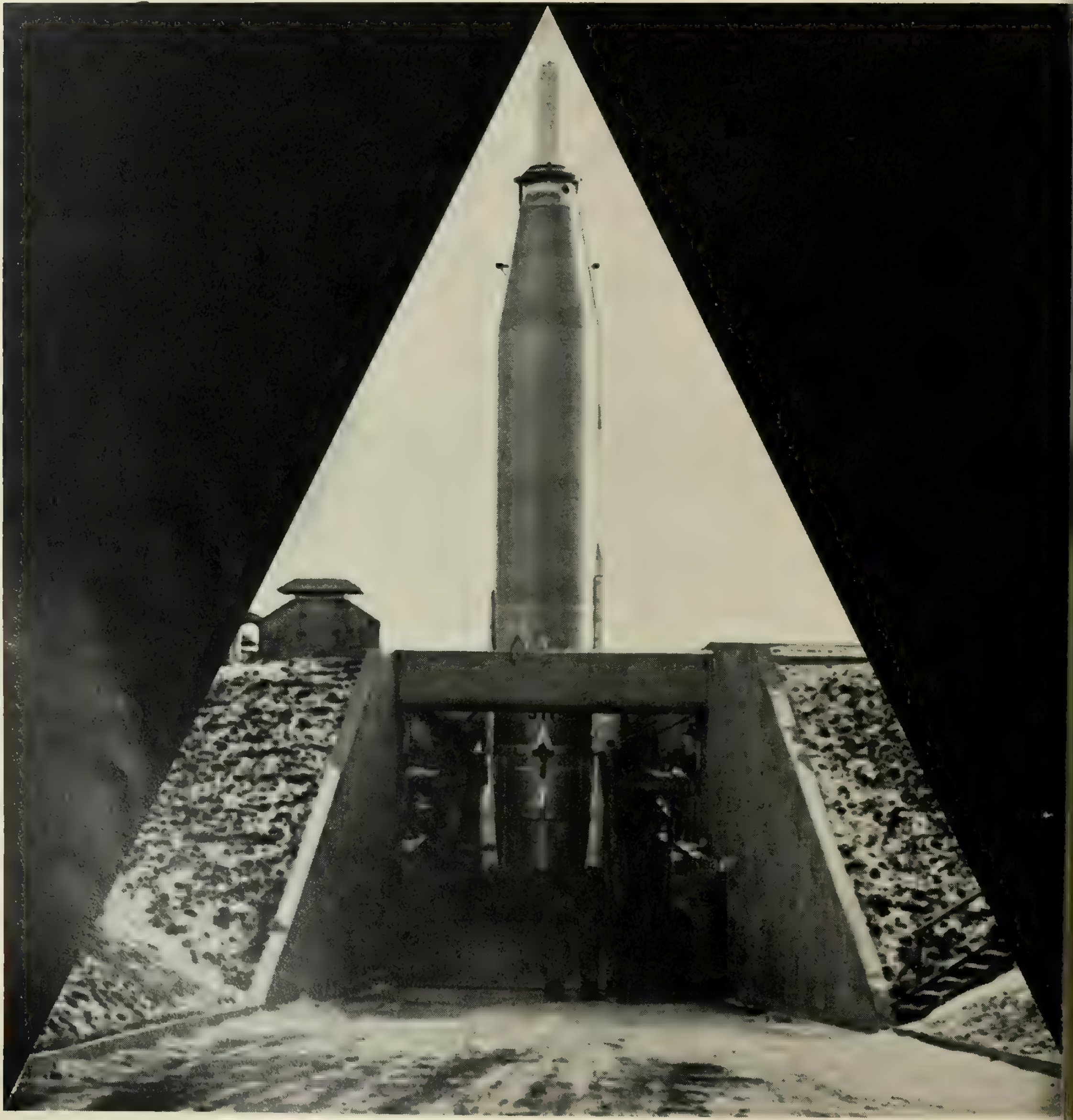

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Decision on Manned Orbiting Space Station Now Due Late in 1964

SPACE AGENCY PLANS now call or a decision in the last half of 1964 n design of a manned orbiting space ation.

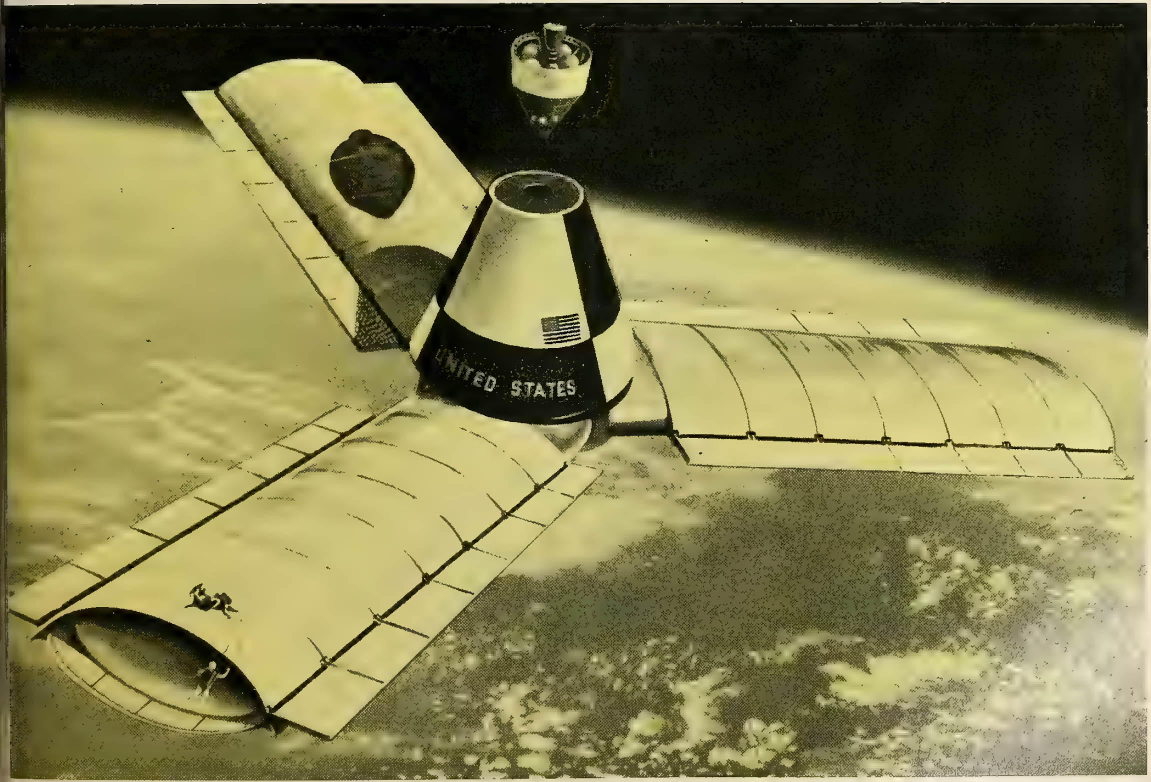
Contending are an *Extended Apollo* pacecraft with a mission module to ost more than $1 billion, and a cylinrical six-man laboratory with an estiated cost of $2.1 billion.

The decision—originally scheduled for early in the year—has been delayed by the recent NASA-Air Force agreement to coordinate in the space station program and the lack of any real hardware development money until Fiscal 1966.

Other new developments in the manned spaceflight project area include:

—NASA has selected the LEM truck configuration for the lunar logistics system. It will select contractors in Fiscal 1964 to do preliminary design work on payloads for the system. While no heavy funding of the program or contractor selection is expected until FY '66, it is anticipated that engineering development work will be funded at a rate of about $10 to $15 million in FY '65.

—Dr. George Mueller, associate ad-



ROPOSED *three-radial module space station concept may be ruled out because little research has been devoted to it.*

ministrator for manned spaceflight, will ask for a supplemental FY '64 authorization to provide funds for backup systems for the *Apollo* spacecraft. A study is now being made of those systems which will be critical in two years. Some likely candidates include reaction control motors, navigation and control systems, fuel cells and components of the Lunar Excursion Module. The request for the supplemental would bring the expected final appropriation bill of $5.2 billion up to the $5.35-billion Fiscal '64 authorization for the space agency. Heavy funding of the backup systems would come in FY '65, Dr. Mueller said. He added that backup systems will not be instituted unless they represent real changes from the systems now under development.

—While no new programs will be instituted in the next fiscal year, the space agency's manned spaceflight budget will rise only slightly above the FY '64 figure of $3.6 billion.

The target for the first manned planetary flight to Mars is now no earlier than 1983, Dr. Robert Seamans, associate administrator, told MISSILES AND ROCKETS.

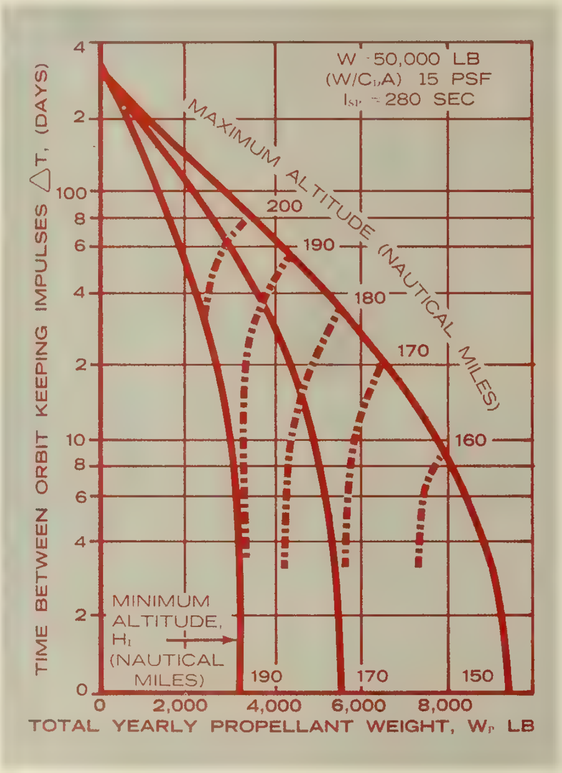
The NASA official said that the best time for a Mars mission is 1972, but this is out of the question under the current funding level. He said that from 1975 to the early 1980's, heavier propulsion requirements rule out the flight.

This means a long delay in development of the *Nova* launch vehicle. Edward Gray, director of advanced manned spaceflight studies, said that "I don't think it has yet been proven that you need *Nova*." He said that orbital assembly operations are still under study for manned interplanetary flight.

- **Lack of decision**—One major factor delaying a start on the space station program is a pending decision by President Kennedy as to whether it will be managed by DOD or NASA. The joint Aeronautics and Astronautics Coordinating Board has been charged with the responsibility of making a recommendation as to the manager and a design which is acceptable to both agencies.

There have been reports that the Air Force may end up with the program, primarily because of NASA's problems of getting Congressional approval for its budgets.

Seamans told M/R that as far as he is concerned, funding will have no effect on the decision. "Management of the project is still a completely open question and I don't think it matters whether the funds are requested from the Space or the Armed Services committees of Congress," he said.



Propellant Requirements for Orbit Keeping

It has also been argued that NASA and the Manned Spacecraft Center do not have enough personnel to run both Project *Apollo* and the space station program at the same time.

This could be avoided by switching the project to another space agency installation. MSC officials now seriously doubt that they will run the program if NASA is selected to manage it. They say it could go to either Langley or Ames Research Centers or to the Goddard Space Flight Center.

Further complicating the decision is the outcome of some pending Air Force study contracts of its requirements and the space station concept which would best fill Air Force needs.

One requirement which the Air Force has talked about is the use of the space station for anti-satellite inspection. It faces, at least in this area, an uphill struggle to convince DOD officials.

Dr. Harold Brown, Director of Defense Research and Engineering, recently declared that DOD believes the most effective anti-satellite system will be ground-based.

Administration officials report, however, that the management decision will not be made until sometime next year. Until it has been made, the space agency will continue its study program of the various space station concepts which have been proposed.

- **Manned space flight study program**—The current by-word in the study program, according to Gray, is to make maximum use of existing hardware and to make sure that dead-end programs are avoided.

This favors the *Extended Apollo,* at least as far as NASA is concerned, for the final station design. That concept would use current *Apollo* hardware, with the exception of a mission module if it is included.

It would also be capable of re-entering at more than Earth-orbital speeds. As a result, it could be used for a planetary fly-by mission.

NASA's manned spaceflight study program in the current fiscal year will total about $28 million. Approximately $9 million will be earmarked for the space station project.

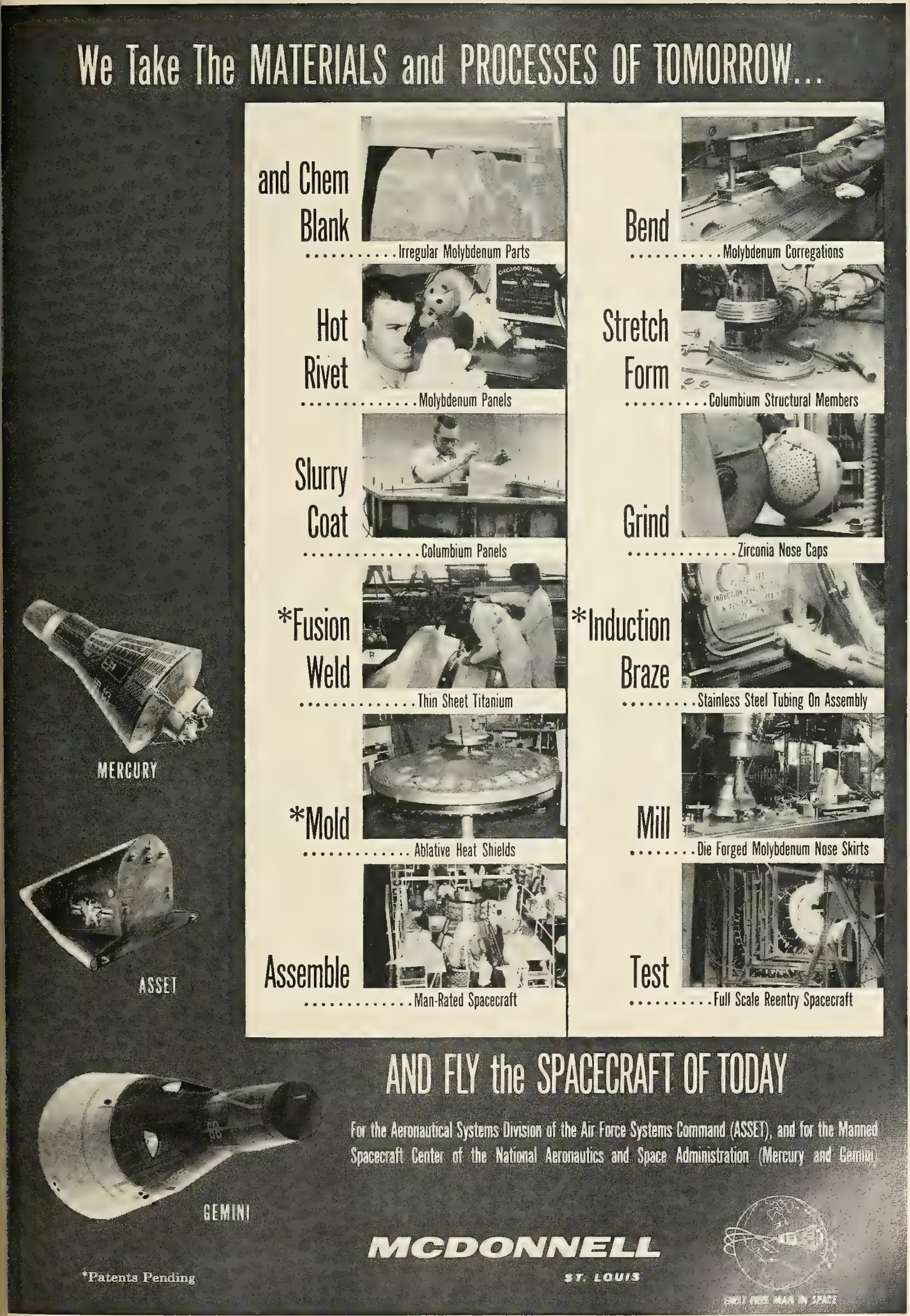
Officials have decided to cancel the Phase II study of the *Manned Orbita Laboratory,* which called for preliminary design. Instead, contracts will be awarded to both the Boeing Co. and Douglas Aircraft Co. by the Langley center, director of the project, to determine what scientific experiments could be conducted on the laboratory.

NASA headquarters also expects to award contracts to further narrow down the design of *MORL*.

NASA recently extended North American Aviation Inc.'s study of how the *Apollo* spacecraft can be modified to achieve a manned space station capability for four months—until April 1964.

The firm will study how a mission module can be placed in the space usually taken up by the spacecraft's Luna Excursion Module. Other studies will also be awarded of the *Manned Ferr Vehicles* and the *Large Orbiting Station,* which would have a capability of supporting a 24-man crew.

If NASA is selected to manage th program, it expects to award a preliminary design contract in Fiscal '65. I would also start engineering and devel opment on critical systems.



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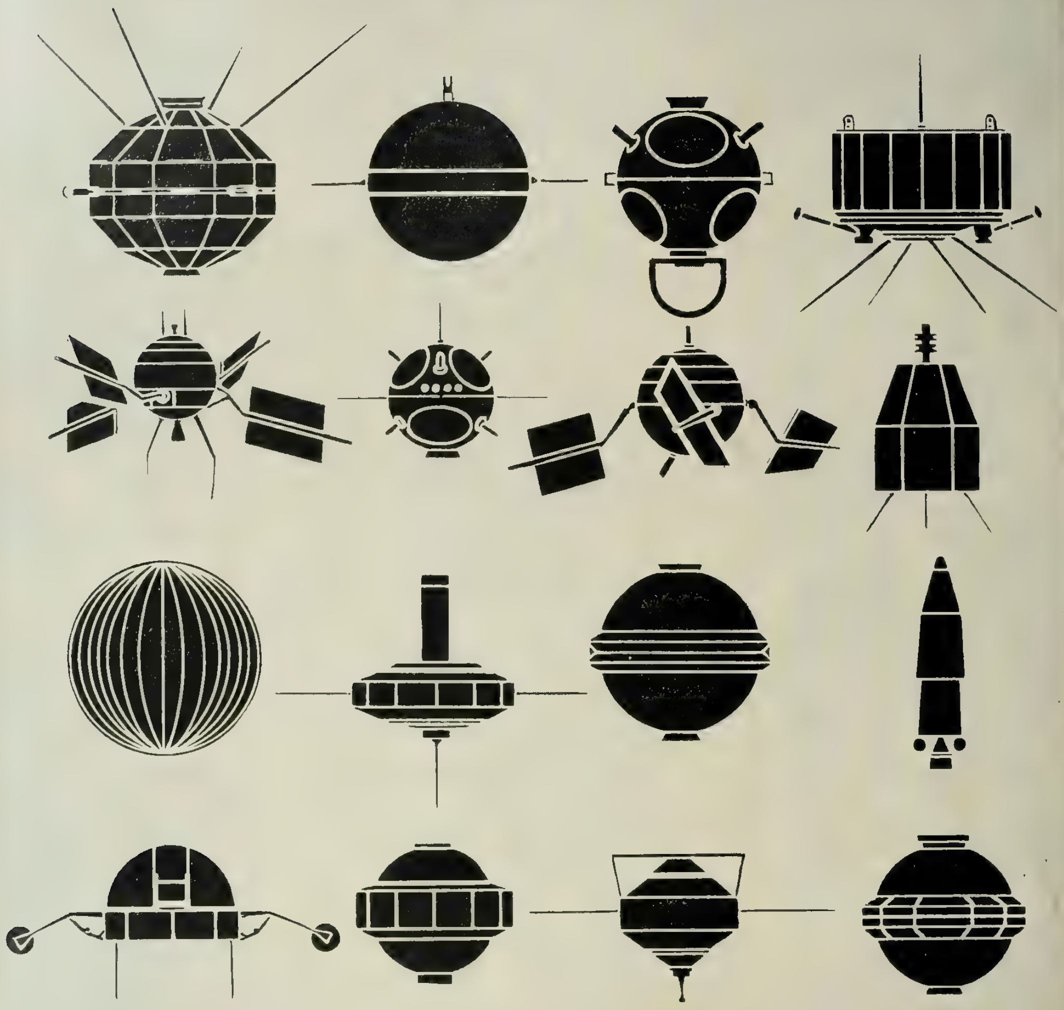

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• **Lunar Logistics System**—Studies n this area in FY '64 will include preiminary design of LEM truck payloads. In Fiscal '65, officials hope to start engineering development of critical systems. No prime contractor is expected to be selected until FY '66 funds are available.

Officials have selected the LEM truck for the Logistics System primarily because it is cheaper than the Direct-Ascent Spacecraft under study, and because by using already existing hardware, it can be ready much sooner.

The LEM truck based on the Lunar Excursion Module's descent stage has an estimated development cost of $400 million. The 90,000-lb. Direct-Ascent system would cost over $900 million. In addition, both systems have an added cost of about $125 million per launch.

The LEM truck's $400-million price ag includes $100 million for the spacecraft, $200 million for payload, and $100 million for miscellaneous facilities.

It would utilize only the descent tage of the two-man Lunar Excursion Module. The capsule and ascent stage would be removed. Such equipment as ttitude control, guidance and navigaion, landing radar, tracking beacon, nd the inertial capsule would be transerred from the capsule into the descent tage.

Other LEM equipment such as the ife-support system, wideband, telemery, and television cameras would not be needed for the unmanned mission.

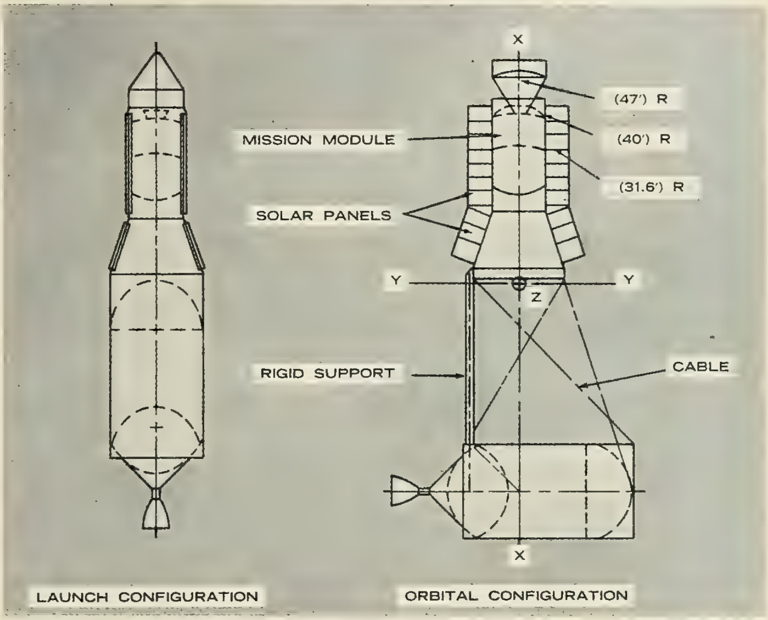
The vehicle would have a payload apability of 7,000 lbs. and would be ble to provide a Moon stay time for stronauts of up to two weeks. The deision to go to the LEM truck system neans that NASA has given up for the ime being any plans to build a large unar base.

Details of the space station concepts nder study follow.

• **Altered Apollo**—The *Extended Apollo* consists of modified Command nd Service modules which would be aunched by a *Saturn IB*. The Service Module would be rather extensively modified by off-loading propellants and providing additional life support stores nd stabilization propellant for an extended stay-time capability. Although he Service Module engine is considerably larger than would be required to provide de-orbit retro-thrust, it would be a proven and available engine. This onfiguration probably can provide a 00-day capability for two men to live in the Command Module. By launching dditional *Apollos* each 100 days and ansferring the men, continuous stay apability can be achieved.

The *Apollo* Command Module is mited in that it provides only about 60 cu. ft. of volume for its inhabitants. Various alternatives are being studied to overcome this lack of space. The most likely solution calls for modifying the Service Module so that a portion could be inhabited. Another answer would be building an inhabitable module in the section usually taken up by the Lunar Excursion Module.

• **The small MOL**—The small *MOL* is characterized by a six-man crew capability. Its main advantage is that it consists primarily of a simple, inhabitable module which requires no assembly or deployment in orbit. It also emphasizes the use of already developed hardware, with the exception of the laboratory module and possibly some internal subsystems.



DIAGRAMS show details of projected Extended Apollo Manned Orbiting Laboratory, with rotation capability. Goal is continuous manned operation.

The zero-gravity *MOL* would be a cylinder of over 4,000 cu. ft. in volume with a docking hub for attachment of manned ferries and resupply spacecraft. It would have two compartments, one with heavy radiation shielding so that it could serve as a temporary shelter during periods of intensive radiation flux increases.

Like the *Extended Apollo*, the small *MOL* is basically a zero-gravity station, but it could be adapted to a negative outcome of the "zero-g decision." In order to provide an artificial gravity field for the crew in the laboratory, the *MOL* and the expended upper stage of the launch vehicle are rotated about their common center utilizing a connecting system of cables or some form of rigidized structure.

As part of the planned biomedical experimentation or as a crew reconditioning device, the use of an internal or external centrifuge has been recommended in the design concepts.

Two launch vehicle classes are being considered for the small *MOL* systems. The first is the *Saturn IB* class, wherein payloads could vary between 18,000 and 28,000 lbs. The second is the *Atlas-Agena/Titan II* class, having payloads from approximately 5,000 to 7,000 lbs. The laboratory itself requires one of the large vehicles for its launch booster. The smaller vehicles may be needed for ferry and resupply operations.

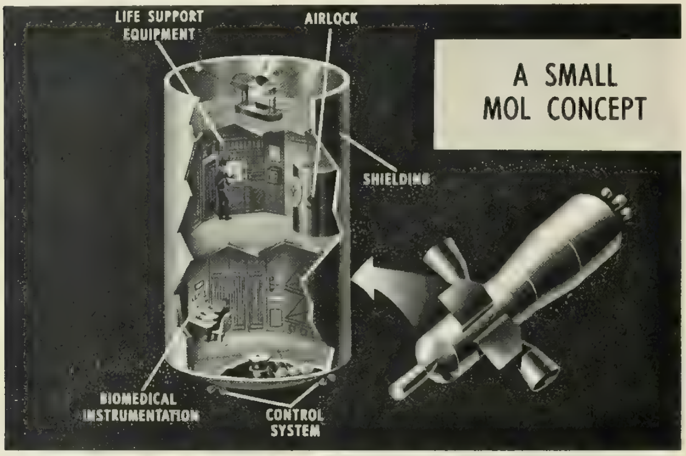
MOL and the last booster stage would be injected unmanned from Cape Canaveral into a 160- to 200-nautical-mile circular Earth orbit with an inclination of somewhat less than 30 degrees. Provisions would be contained for supporting the *MOL* and a two-man crew for about two weeks.

Critical systems, such as life support and power, would be activated by ground command and monitored by telemetry to determine proper operation prior to the initial manning operation.

Crew replacement could be accomplished by a ferry spacecraft using launch, rendezvous, re-entry, landing procedures, operations and landing sites currently planned and being developed for the *Gemini* program. The application of an *Apollo-Saturn* ferry vehicle is also being considered. This system would have the additional capability of carrying on-board supplies with the crew.

The choice between *Gemini* and *Apollo* ferries and their respective boosters is presently unresolved and will depend on the operational requirements for crew replacement and resupply.

In the case of a *Gemini-Titan II* ferry concept, there is little payload margin for logistics cargo; the latter could be delivered by a separate resupply spacecraft of the *Atlas-Agena D* class. This logistics spacecraft would be equipped with control and propulsion systems for maneuvering and docking which are controlled remotely, probably by the *MOL* crew. The first resupply spacecraft would be launched anytime within the first two weeks after the first two-man crew has boarded the *MOL*. It could carry about a 90-day supply cargo, thus necessitating a logistics launch every three months. To be fully effective, the craft with its launch vehicle must be capable of providing consumables to the *MOL* on a reliable schedule; in addition, it must be able to accept some degree of emergency demand.



SMALL MOL CONCEPT has advantages of simplicity, no requirement for assembly in orbit, and utilization for the most part of already existing equipment.

- **Weightlessness study**—Determining the effect of weightlessness on man's ability to withstand re-entry forces requires that the astronauts be exposed to re-entry decelerations after ever-increasing periods of weightlessness. In order to lay the groundwork for future planetary flights, man's reaction to as much as a one-year exposure to weightlessness must be explored.

A carefully planned crew rotation schedule will be used to conduct that biomedical experiment. One plan is based on a four-man station with a one-year mission duration and five crew transportation launchings.

After the *MOL* has been placed in orbit and its components adequately checked out, the first ferry vehicle transports two men to the laboratory. Thirty days later the second ferry is brought up, and if all has gone well for the first two men, the second two will remain to complete the crew. After another 30 days, the third ferry vehicle with two astronauts would arrive and return carrying one of the first crew members who has been exposed to weightlessness for 60 days.

One of the astronauts on the third vehicle would return with it as the pilot for safety, since it is possible the first astronaut's exposure to weightlessness might have caused him to lose his ability to operate under high accelerations.

If the return trip and ground medical examination of the first astronaut have proven him to be in good condition, the program continues. During this period, one of the first astronauts has been kept in space the complete time and he would provide the total 360-day experience. Six other men would also have been tested at time ranging from 50 to 300 days in orbit.

- **Large space stations**—The large *MOL* would have a crew ranging from 12 to 24 men. It would be launched by a *Saturn V* booster. The size ranges from 150 to 200 ft. in diameter, and internal volume is on the order of 50,000 cu. ft.

The large station studies have ranged from inflatable toroidal concepts to huge stations assembled in orbit.

The major feature of most large *MOL* concepts under study is that they provide for continuous rotation, thus creating an artificial gravity field. Non-rotating central hubs can be utilized as zero-gravity laboratories. Radial spokes would be areas of varying gravity fields as one proceeds toward or away fro the rim of the station.

The size of the station, the larg crew and the varying gravity field would allow the large *MOL* to functio as a versatile space laboratory, and i could be adaptable to operational growt into an elaborate orbital launch facility

One of the large rotating *MOL* con figuration designs, now being studie in greater detail, is the three-radia module type. It is comprised of a hang ar-type hub area and three radiall deployed modules. The diameter of thi station would be approximately 150 ft. and it would rotate about its axis o symmetry at 3 to 4 rpm. The statio would generally be oriented to poin its axis of rotation in the direction o the Sun so as to best utilize the solar cell power plant deployed outboard o each radial module.

The hub of the station would contai an environmentally controlled area fo service and checkout of logistics space craft, and a zero-gravity laborator would be located in a circular are below the hanger. The zero-gravity laboratory would not be rotated, but woul be mounted on bearings to allow for th relative motion between it and the res of the station.

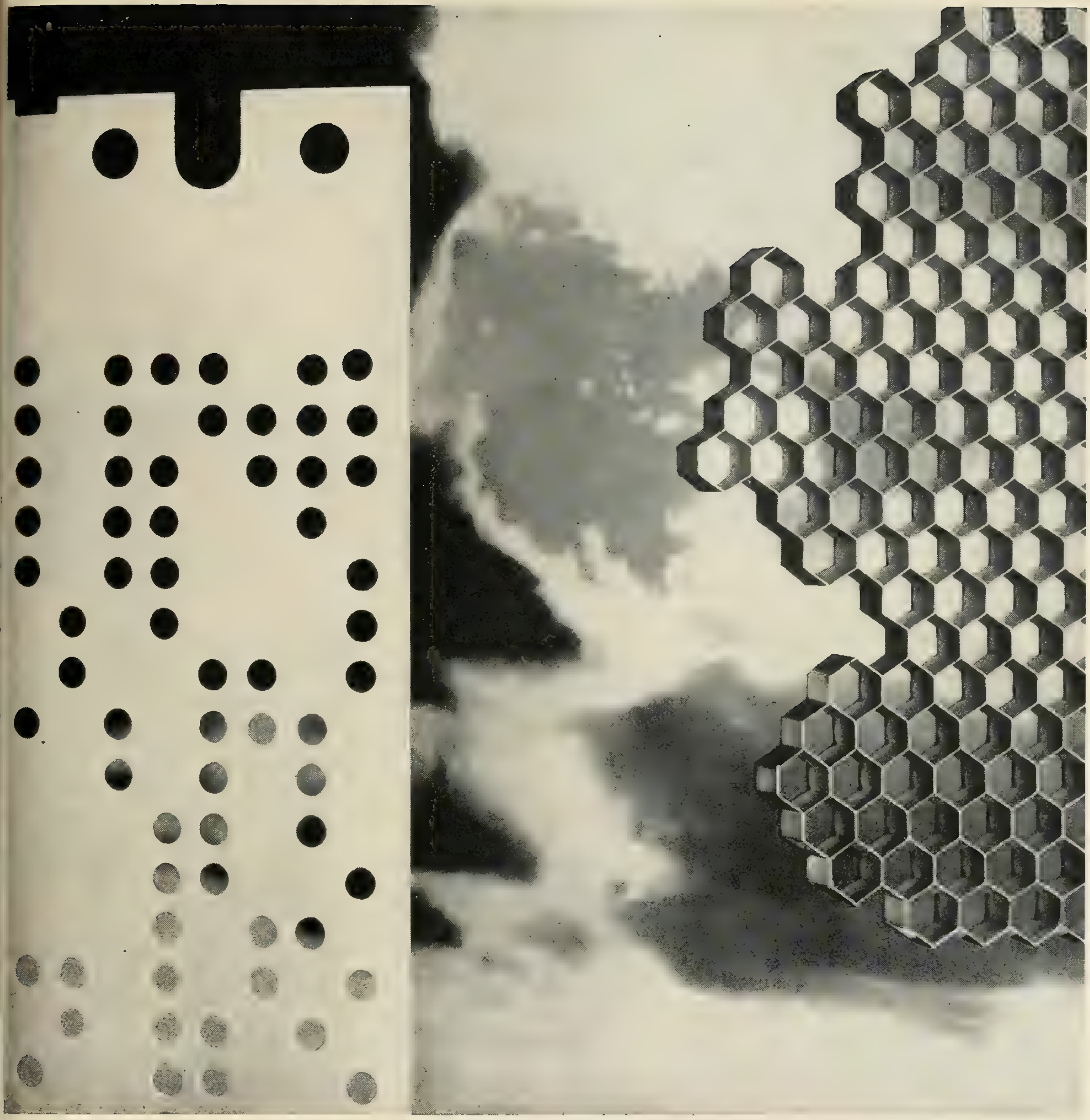
During launch, the radial module would be folded down so that the axi of their cylindrical areas would be parallel to the axis of the hub.

The space vehicle would be launche with the space station unmanned an with a crew of six in a modified *Apoll* logistics spacecraft atop the spac station.

After injection into orbit, deployment of the radial modules would b initiated. On completion of deploymen the ferry spacecraft would be separate perform a turn-around maneuver an dock with the station. Then it woul be towed into the hangar area, and th crew transferred into the space statio to activate the on-board systems. I this concept, no extravehicular operations are required. Once the systems ar activated, the station is then spun up t the required angular velocity.

The development of a resupply ve hicle on a combined resupply ferry usin *Saturn I* launch capability will reduc the total number of launches necessar for large *MOL* support. Effective su port for differing *MOL* crew sizes an replacement schedule requirements ca be satisfied by the availability of such six-man carrier.

Full utilization and cost economi realizable with even larger launch v hicles (such as *Saturn IB*) will genera designs for even larger ferry vehicl such as a 12-man ballistic re-entry ferr logistics vehicle or a 12-man lifting bod vehicle.



Program for a mission, pattern for a launcher

Punched cards and aluminum honeycomb played an important part in the development of an advanced ECM simulator, and production of a lightweight launcher for ASROC. While the design problems were different, they were solved by a similar capability—engineering skill and ingenuity offered by Universal Match Corporation's Government Products Group.

A simple punched-card system provides a flexible method for programming the T-4 Electronics Countermeasures Simulator, developed by Reflectone Electronics, Inc., a UMC subsidiary. T-4 can duplicate virtually any RF condition which a B-52 ECM officer might encounter over enemy territory.

Engineers at UMC's Unidynamics Division combined light weight and high strength needed for ASROC's unique launcher through use of honeycombed aluminum. The unit not only nests eight missiles above deck, but also serves as launcher. This imaginative design technique points the way toward more reliable launchers of increased mobility.

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Unmanned Interplanetary Programs Will Get Bigger Funding in FY '65

Voyager and Advanced Pioneer face delay until Fiscal '66; Mariner C fly-bys likely to be dropped in favor of B version; a status report

A CONTRACTOR for the *Voyager* spacecraft program will not be selected until mid-1965 at the earliest.

The *Advanced Pioneer* project—another spacecraft program currently in the study phase—faces the same sort of funding picture—delay until Fiscal 1966.

Despite the lack of new projects, the Fiscal '65 budget request for the interplanetary spacecraft programs is expected to rise above the Fiscal '64 request of $322 million, primarily because such in-being projects as *Surveyor, Lunar Orbiter* and *Mariner* will be reaching their funding peaks.

Falling short of the current request, final Congressional appropriation is expected to provide about $275 million for Fiscal '64.

Space agency officials have just about given up hope of having *Voyager* ready for the 1969 Mars launch opportunity. The most probable launch date now is in the 1972-73 period. While NASA scientists expect to make a start on the program in Fiscal '66, the new launch date could put off hardware funding until 1967-68.

NASA scientists estimate that, if approved, the development of this program over a five-year period, carrying it through the first series of launch opportunities, might cost at least a half-billion dollars.

As currently envisioned, early funding would probably be at about a $30-to-50-million level, probably covering a portion of one year, with the program eventually averaging out at about $100 million annually. The decision as to what budget *Voyager* will have will be made at the top NASA headquarters management level.

In addition to the slippage in the two major future programs under study, other new developments in the unmanned interplanetary spacecraft programs include:

Some savings are anticipated in the *Mariner* program. *Mariner* will be funded as a broad exploration project; however MISSILES AND ROCKETS has learned that most of the funding and effort will go into development of the heavier *B* version of the spacecraft, which includes a landing capsule in its payload, as opposed to the *Mariner C*.

As a result, two *Mariner C* planetary fly-bys contemplated for 1966 probably will be dropped in favor of continuing with just the two *Mariner B* flights to the vicinity of Mars (with subsequent capsule ejection) also planned for 1966. NASA says work on *Mariner B* will get under way later this year.

In the future, management of lunar and interplanetary programs, particularly the latter, is apt to be more diversified than in the past, when virtually all projects in this area fell under Jet Propulsion Laboratory control.

Main reason for this diversification is that as unmanned space probes become more complex and move into even more extreme flight profiles and planetary environments, the areas of specialized competence which have been built up within the strong NASA centers concerned with this phase of the space-program—Ames, Goddard, Langley and JPL—must be brought to bear upon program management. This type of complexity will no doubt lead to multiple center management, perhaps beginning with *Voyager*.

New NASA studies are apt to focus on the planet Jupiter as the next step in planetary exploration. Studies of a comet probe may also be initiated. Such an investigation probably would be highly hardware-oriented, says NASA, with major emphasis placed on how to conduct such a mission and what type of vehicle and payload would be required.

A status report on the interplanetary spacecraft program follows.

- **Advanced Pioneer**—Study contracts let by Ames Research Center to General Electric, Martin-Baltimore and Philco Western Division Laboratories have indicated the feasibility of extending *Pioneer* investigations from 0.3 AU and to 2½ AU.

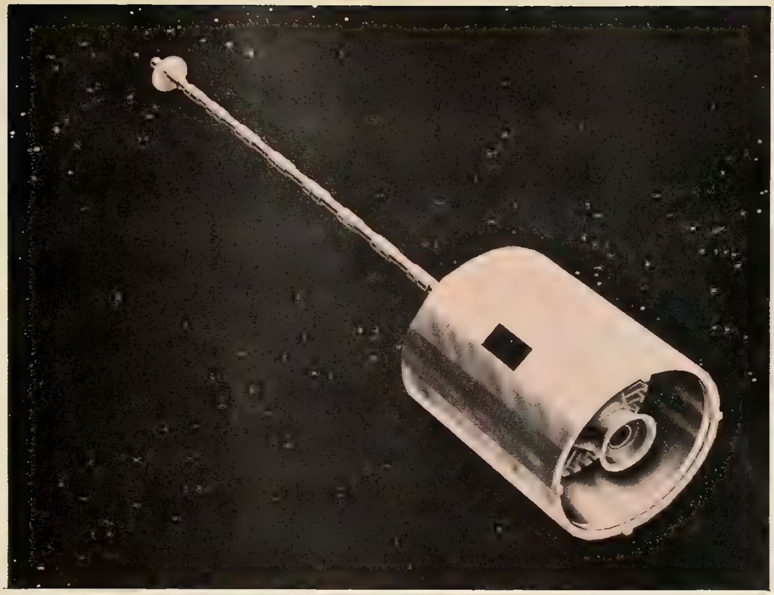
The aim of *Advanced Pioneer* would continue to be the gathering of particle and field data in the interplanetary medium. First launch would be late 1967 or early 1968.

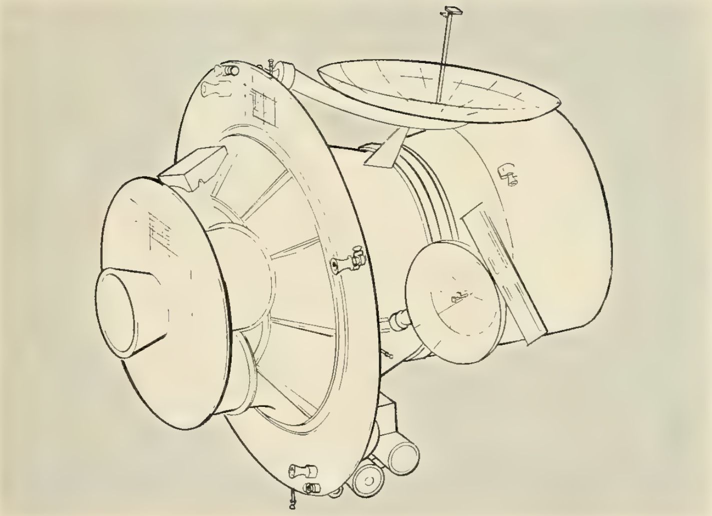
Studies made by the three firms tend to suggest the following configuration for the spacecraft. It would be a 375- to 425-lb. vehicle with 50 to 70 lbs. of scientific experiments. Three-axis stabilization, Sun and Canopus reference, rather than spin stabilization, would be required.

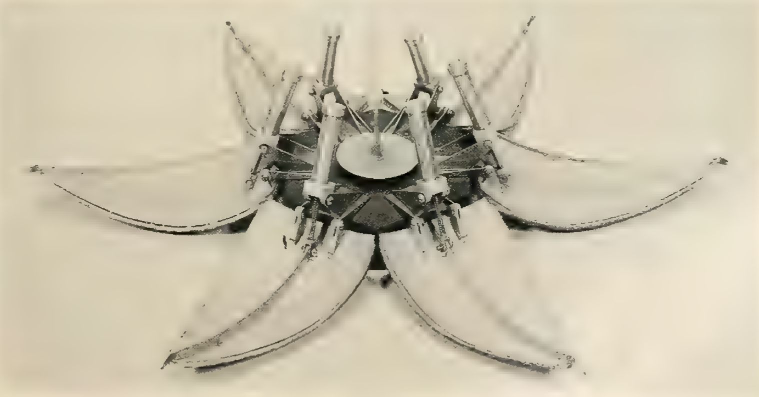
Reason for the change is the need for increased solar protection on near-Sun orbits and the need for a steerable high-gain antenna.

Ames has recommended to NASA Headquarters that a Phase I start should be made on the project in Fiscal 1965. This would involve detailed design

TOP: Artist's concept of Pioneer solar probe being developed for space agency by Space Technology Laboratories, Inc. First launch is scheduled for 1965. CENTER: Drawing of Avco Corp.'s Voyager spacecraft concept developed under NASA study contract. Concept includes an orbiter bus and a landing vehicle. BOTTOM: Avco design of a Mars lander for Voyager has an acorn shape. Protected by a heat shield during peak aerodynamic braking, lander descends by parachute.







studies before hardware production.

No real breakthrough is required to make the project feasible, but there are some problem areas. One unknown is the stability of thermally protective coating in the temperature and radiation conditions that can be expected near the Sun.

With a 4-ft. paraboloid and a transmitter output of 20 watts, the probe is expected to provide an information rate of 30 bits per second over distances of 2½ AU.

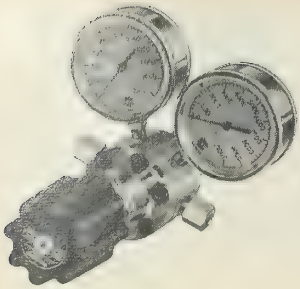
Most likely launch vehicle for *Advanced Pioneer* is said to be an *Atlas-Agena* with a solid-fuel third stage.

- **Voyager**—Study contracts on future unmanned spacecraft communications have been completed by Avco, General Electric and the Jet Propulsion Laboratory. They have concluded that a breakthrough in information rates for future spacecraft, such as *Voyager*, will only be possible by going to weights of 6,000 to 7,000 lbs.

Starting point of the study contracts was to find out what types of experiments were desirable on future spacecraft. It was decided that high-grade experiments need transmission of visual data at high bit rates. In turn, this demands high transmitter powers and wide bandwidths, and leads to the weights specified.

Hanging over *Voyager* is a key question: Just how much is interplanetary exploration worth? Attempts are being made to gauge how strong scientific motivation is in this area of research.

Indications are that this motivation alone is not strong enough to pay for



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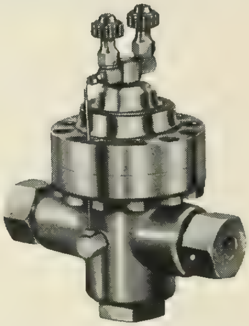

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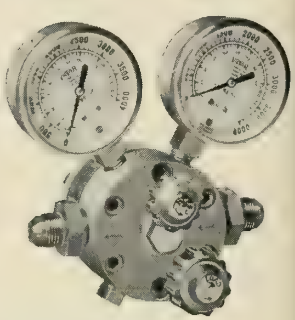

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a *Voyager* shot before 1970. After that date, however, interest in Mars will be increasing.

Voyager is to be a combination of planet orbiter and lander. If *Mariner B* is successfully launched in 1966, there should be sufficient time to firm up the design of *Voyager* and have it ready for launching toward Mars in late 1970. But this is an optimistic schedule. *Mariner B* with a capsule is not likely to fly until 1968, and *Voyager* might then follow in 1972-3. Limited hardware funding might be expected between 1967 and 1969.

- **Mariner B**—For the 1966 Mars probe, a *Mariner B* weighing more than 1,000 lbs. might be launched by an *Atlas-Centaur*. This will be the first attempt to eject a capsule from a probe to the surface of a planet. However, since planetary missions are not scheduled this far in advance, predictions are uncertain.

Initial studies suggest that the capsule may be spin-stabilized and separated from the probe at some distance from Mars. The capsule's energy would then be absorbed by the atmosphere instead of by retro-rockets.

Main experiments foreseen for the capsule are atmospheric scale height measurements, atmosphere surface-pressure measurements and an extraterrestrial biology experiment.

Chief problem with *Mariner B* is making a spacecraft of such complexity reliable. Some instrument development applicable to the spacecraft has been carried out, but there has been little work on the mechanization of capsule instrumentation and injection. It is quite probable that launch of a probe of this type will be delayed until 1968.

- **Jupiter**—A probe of the *Voyager*-type boosted by a *Saturn V* could be used to investigate Jupiter. Accuracy requirements for the trajectory are about ten times those needed for the Venus fly-by. This could be achieved by two mid-course guidance maneuvers about six months apart.

Voyage time to the planet would amount to about two years, and some degradation in telemetry capability would occur because of the distance.

Other planetary missions of interest are:

Out-of-ecliptic shot—on such a flight, it should be possible to observe the Sun for latitude effects. With an *Atlas-Agena* and a solid-fueled third stage, an *Advanced Pioneer* might get out to 15 degrees from the ecliptic. By using a *Centaur* second stage and sacrificing closeness of solar approach, an orbit at 20 degrees to the ecliptic could be achieved. Replacement of *Centaur* would provide a capability of reaching out to 30 degrees from the ecliptic.

Solar probe—Studies are under way to discover the importance of experiments that might be made with a solar probe that approaches to within 0.1 AU of the Sun.

To take 400 lbs. this close to the Sun would call for a *Saturn V* equipped with several *Centaurs* in a third stage, putting the pricetag at something like $100 million per launch.

There is the possibility, however, that this expense can be avoided by using the technique of planetary encounter. By bringing a probe close to a planet, it can be made to gain energy from the planet's gravitational field and be accelerated like a sling shot.

One penalty imposed by this approach is the narrow launch window allowed by the infrequent appearance of a planet in the correct locations.

- **Mercury**—Mercury is interesting because it presents ony one hemisphere to the Sun. The cold side might constitute a considerable storehouse of light elements. The twilight zone, which because of the ellipticity of the planet's orbit, passes slowly through alternate light and dark periods, may hold some sort of migratory life.

One point in favor of Mercury for exploration by a space probe is the fact that it has a light atmosphere that probably extends out farther than the Earth's atmosphere, and so provides for more gradual deceleration of probes approaching the planet.

Launch periods occur several times a year instead of every 18 months for Venus and 26 months as for Mars.

These considerations suggest that a Mercury lander might be given higher priority than a Venus lander.

Mercury's orbit lies at about 0.4 AU from the Sun so that a fly-by by a probe of the *Advanced Pioneer* type would be feasible. A *Voyager* would also have the capability of reaching this planet.

Current programs in the interplanetary field:

- **Mariner C**—The *Mariner C* fly-by of Mars in November, 1964, is primarily intended to upgrade visual knowledge of the surface of Mars. It is acknowledged to be a riskier venture than the successful *Mariner 2* Venus probe. Both Russian and U.S. experience indicates that in the current state of the art, the maximum lifetime of spacecraft electronic systems is about 3,000 hours. The trip to Mars will require nearly twice that. However, project officials are confident that the time and money spent since the flight of *Mariner 2* make the Mars mission feasible.

Mariner C will have a gross weight of 570 lbs. and will carry about 40 lbs. of instruments.

- **Pioneer**—Early in 1965, a set of two *Pioneer* probes is supposed to yield time-coordinated measurements of the interplanetary medium. A second set of two is scheduled late the same year or early in 1966. Experiment packages can be expected soon.

Contractor for the 120-lb. spacecraft is Space Technology Laboratories, supervised by the Ames Research Center. Main feature is a low residual magnetic field, to make possible sensitive measurements of the interplanetary magnetic field.

A three-stage vehicle will be used for launching, but the exact configuration has not yet been selected.

Unmanned lunar projects, originally emphasizing basic research, are now largely devoted to collecting operational data for *Apollo*. Among these are:

- **Lunar Orbiter**—This Langley-managed development is the latest in the family of lunar spacecraft. It succeeds the concept of an orbiting *Surveyor* spacecraft which had to be abandoned because the center stage needed to lift it will not be available in time. The Langley orbiter is to be launched by an *Atlas-Agena*.

The new vehicle will be spin-stabilized rather than controlled. The *Surveyor Orbiter* had been designed to take pictures which would have formed a continuous strip chart, including potential landing sites. The *Agena*-launched *Orbiter* will only be able to photograph a scattering of carefully oriented squares, but its resolution will be better and may approach one meter.

- **Surveyor**—Now rescheduled for the first quarter of 1965 and with its payload reduced from 2,400 to 2,100 lbs., *Surveyor* is intended to make a detailed certification of an *Apollo* landing site, 1,600 to 1,800 meters in diameter. The first *Surveyor* is designed to fly a direct trajectory from Cape Canaveral to the lunar surface. Original intention had been to start the transfer trajectory from an Earth parking orbit. The new plan is thought to improve mission reliability by eliminating one engine re-start sequence in space. It reduces, however, the frequency of launch opportunities and the width of the launch window by half.

- **Ranger**—The Block 3 series in the *Ranger* project is about to enter the flight phase of its existence and is intended to relay television pictures of the lunar surface before the spacecraft crash there and are destroyed. Block 3 is the last group of *Rangers* to be managed directly by JPL. Block 4 has been eliminated from the program and the hard-landed Block 5 will be managed by Norair Div. of Northrop Corp. A firm decision on payload has not been made. A front-runner is the balsa-cased seismograph developed by Aeronutronic Div. of Philco. ■

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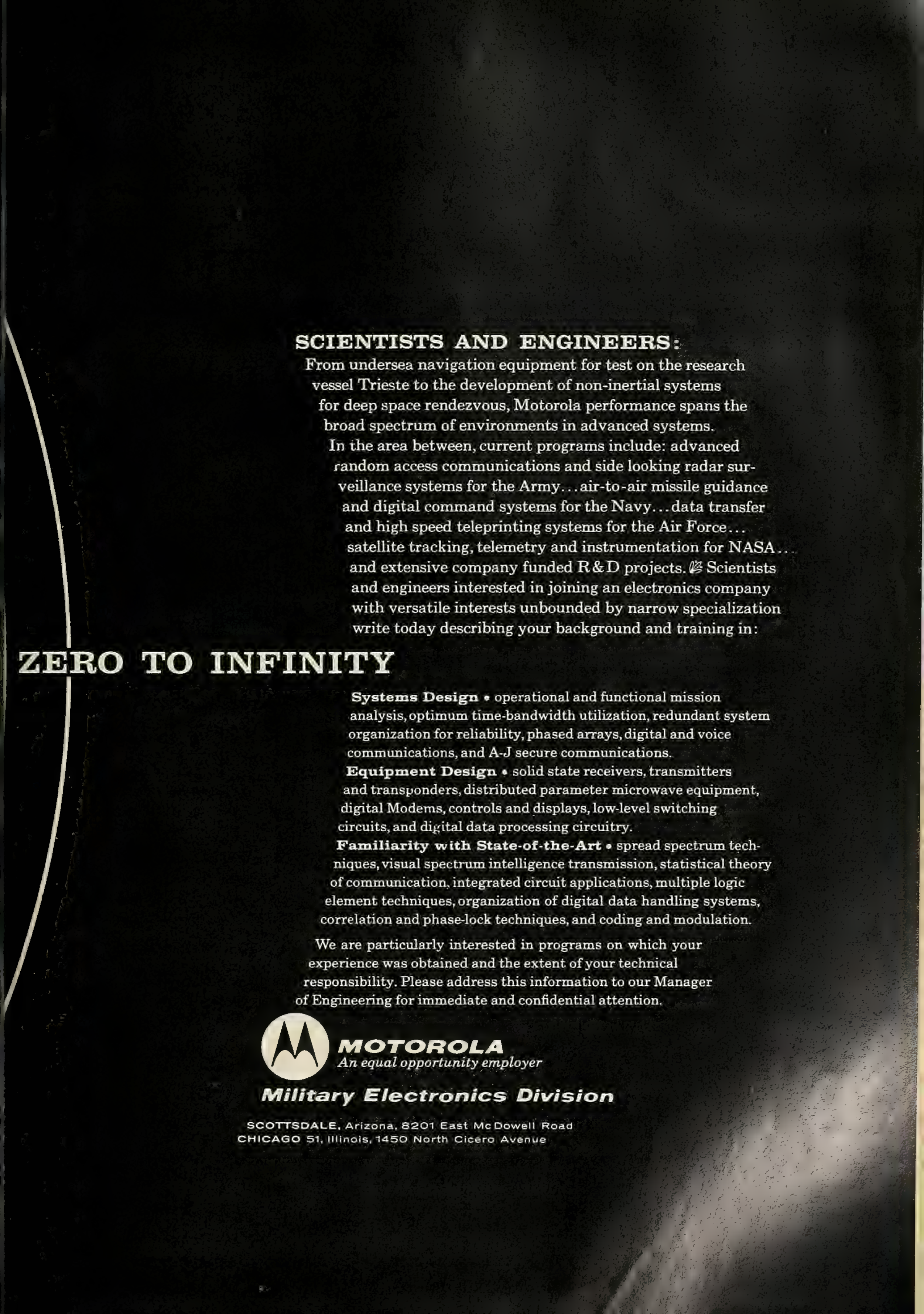

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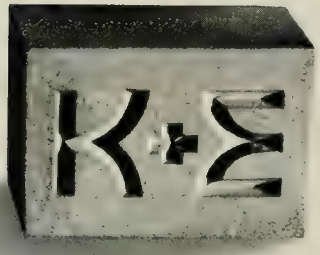

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Accord on New Weather Satellite Awaited; Future Applications Studied

Space agency, Weather Bureau must agree on practicability of 3-5-year lifetime; communications efforts center on the Advanced Syncom; variety of other applications in planning

A DECISION on a new meterological satellite (MetSat) system may be announced by the end of this year if NASA and the Weather Bureau can agree on whether it is both feasible and practical to design a satellite with three to five years' lifetime.

The Weather Bureau is pushing this requirement in the belief that this is the only way to attain an economical operational system. Although NASA is somewhat reluctant to make a commitment, the Bureau acknowledges that there is no other source to which it can go.

Technical managers at the Goddard Space Flight Center say that it will take 10 years and perhaps a half-billion dollars to achieve this kind of predictable lifetime in meteorological satellites. The techniques must begin at the basic components and materials they say. Furthermore, NASA is not necessarily convinced that such lifetimes are cheaper in the long run. After about 18 months, they say, there are diminishing returns for the expense of constructing such a vehicle.

Spokesmen for the Bureau said there is little chance it will reverse its decision to drop funding of the *Nimbus* satellite, which it felt had too short a lifetime.

Dr. S. Fred Singer, head of the Bureau's satellite program, told MISSILES AND ROCKETS that in the meantime the Bureau has decided on an interim system utilizing existing *Tiros* technology. He said it very likely would consist of *Tiros*-type cameras in two spacecraft in polar or near-polar orbits. NASA will be asked to handle whatever development might be necessary, he added.

This interim system would begin operation after the already programmed *Tiroses* are expended (seven of these remain, including both the Bureau's and NASA's) and continue until the new system was ready.

Singer added that one of the Weather Bureau's major concerns was to make effective use of its satellite readout station at Fairbanks, Alaska, which was constructed for the *Nimbus* program.

- **New NASA contracts**—Although NASA does not believe that a solution may be immediately forthcoming, much of its advanced research work is directed to the problem of satellite lifetime. Much of the work will remain in-house until the problems are identified, but eventually it will be contracted.

These ideas about future projects were expressed by top NASA officials both at headquarters and at Goddard Space Flight Center:

- **Power**—NASA officials say power is the most severe technological problem for satellites requiring boosters below the *Saturn* class. Prospects for solution appear bleak.

Nuclear power is the obvious answer, but it may take a national policy decision to produce enough fuel or allow the use of fuel such as Strontium 90. NASA scientists point out that while SNAP 9A, which will be tested on *Nimbus* in 1966, provides about 25 to 50 watts, operational meteorological satellites will require about 1,000 watts of power.

Solar cells remain the most feasible source of power, but practically the only way of increasing their efficiency is enlarging the size of the panels. Some work is being conducted in basic materials development and decreasing radiation sensitivity, but even a 10% improvement will be attained only at great cost. Battery development has always needed improvement, and continues to need it, meteorological satellite officials report.

- **Controls**—The technique of spin-stabilizing satellites—such as *Tiros*—has too many limitations, NASA officials agree. Broader coverage will be attained in the cartwheel *Tiros* satellite, which employs a magnetic orientation coil device to keep it in place. Dr. Morris Tepper said NASA is thinking about canting the cameras on the cartwheel *Tiros* to 30°, which would get broader coverage of the Earth's cloud cover.

NASA may look to improving the lifetime of the *Nimbus* satellite—which depends on a gas reservoir for active stabilization—by increasing the size of the reservoir or by modifying the satellite to use a gravity-gradient, passive method of stabilization.

The agency may go into a real research and development program to determine whether gravity-gradient holds the key to the controls problem. Tepper points out that *Nimbus* could easily be modified—by adding a spring which could be extended upwards into space. The force of gravity on the lower portion of the mass would keep it erect.

Besides the Earth stabilization problem, yaw control is very important to meteorological satellites. W. G. Stroud, chief of aeronomy and meteorology at Goddard, said an experiment in yaw control is planned for *Nimbus* in 1966-67.

A combination of passive and active control systems may be the direction controls development must move. This might involve a combination of gravity gradient and a gyro system in one vehicle. Other techniques such as combining gyros and magnetic torquing

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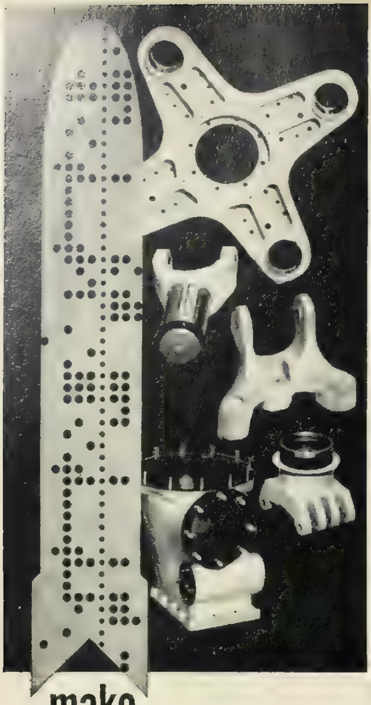

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seem feasible, but there is no experience in them yet, NASA officials say.

Tiros could be used for a gravity gradient experiment, MetSat officials point out, since its behavior is so well understood.

• **Camera development**—The APT (Automatic Picture Transmission) storage vidicon camera system has several serious drawbacks, both in quality of the pictures and in lifetime.

The original 800-hour lifetime for the APT system may be extended to 2,500 hours by next summer, but even longer lifetime is desired. The problem of quality seems to be a state-of-the-art problem, according to Stroud. At present, manufacturers average only about seven good tubes in 100 manufactured, the main problem being the deposition of materials on the face of the tubes.

About $1 million will be invested in basic vidicon improvements. This includes nighttime cloud cover image orthicons as well as APT and AVCS (Advanced Vidicon Camera System scheduled for *Nimbus*). This tube development will be contracted out.

• **Storage of information**—Storage of data is a key problem. Stroud pointed out that storage devices must handle information of the magnitude of 10^8 bits. Magnetic tapes still appear to be the best bet, since magnetic cores are much too big for satellite use. Lockheed Electronics is now preparing for flight a Goddard-developed 1,200 bits/in. tape recorder, but it may be 5 to 10 years before a really adequate high-density storage system is developed.

• **Infrared systems**—MetSat officials stressed the desirability of digitalizing all systems possible, including infrared cameras. The High Resolution infrared device (HRIR) on *Nimbus* probably will be digitalized, and officials say they are thinking about providing direct readout of this system as in APT. Another possible development is the melding of the APT and HRIR system on the same telemetry, so that one could be used by day, the other by night.

• **Other measurements**—NASA still is on the lookout for other means of making meaningful meteorological measurements by satellite. The RAND Corporation is now reviewing data on the entire electromagnetic spectrum to provide a basis of theoretical work. NASA has invited physicists, private or company, university or foundation, to suggest possible measurements.

Passive microwaves, ultraviolet, and radiowaves are some areas of the electromagnetic spectrum which may offer meaningful data. These are now being studied.

To the meteorologist, the information most desired is: remotely measured pressure to a minimum of three millibars accuracy; the vertical distributio of temperature; and the vertical distribution of winds.

• **Digital systems**—Goddard official are pushing the design of digitalize systems and changeover of present systems, because of their higher reliability This is essential for long life, Strou points out.

COMMUNICATIONS SATELLITES

NOT HAVING to face some of th weight and stabilization problems of th meteorological satellites, NASA's advanced communications effort is directed at systems which might be use for three years.

Their thinking is primarily addressed to the development of *Advance Syncom,* which they hope will weig at least 500 lbs. and be launched int a synchronous orbit.

Much of this work will depend upo booster technology, since new uppe stages will be needed. The satellite wil need its own propulsion for period control and orientation.

While *Syncom* proved one technique—cold-gas propellants—NASA' director of communications satellites Leonard Jaffee, said his department i looking at others, such as bi-propellants, and later, subliming solid-rocke motors and electrical propulsion. Som work already has been contracted ou on components.

• **Power again**—The power requirements of satellites beyond the *Advanced Syncom* put development at leas a decade away. One such satellite a home-receiving broadcast satellite would require something beyond SNA 8, Jaffee said.

Some basic research on solar powe supplies will be done on *Advance Syncom,* with a view to assessing th long-term environmental effects. Th solar cells will be monitored continuously to measure and identify partic hits, and to determine their effects.

• **Control systems**—The spinnin satellite does not pose the same restrictions on communications applications a it does in meteorology, except for pi point transmission to small ground stations. Even so, there is a possibilit that a portion of the spacecraft coul be de-spinned.

Research aimed at gravity-gradie systems will be conducted in extremely low-thrust control systems, suc as electrical propulsion or sublimin solids, so that the gravity gradient i not upset. Passive energy devices t damp oscillation motions also are bein considered.

Some engineering attention wi have to be directed to the thermal problems of the Earth-oriented satellite als Jaffee points out.

- **New frequency possibilities**—NASA has a program in the next fiscal year to investigate the possibility of using frequencies above 10 kmc. This is a real problem, Jaffee said, since the current 2-10-kilomegacycle area is becoming congested. NASA is now considering ways of performing an experiment from a satellite to see what the transmission characteristics are in these frequencies in the space medium.

- **Reliability**—Design of a three-year satellite requires some new thinking in components design. Failures so far in the communications satellite program have been considered "random," and NASA officials are not entirely sure what to look for.

Goddard communications division manager Alton E. Jones said he would particularly be looking at systems with moving parts, such as the nitrogen and peroxide valves, an antenna relay switch, the antenna itself; for electronic failures perhaps caused by radiation; and for extended lifetime failures.

- **Direct ff/rf converters**—According to research director Robert J. Mackey, Goddard is now looking at two methods of directly converting radio signals. One method, now on contract, is by re-entrant traveling wave tube. The other, somewhat less promising, is modulating the signal in the traveling wave tube with a sawtooth wave. This work is going on in-house.

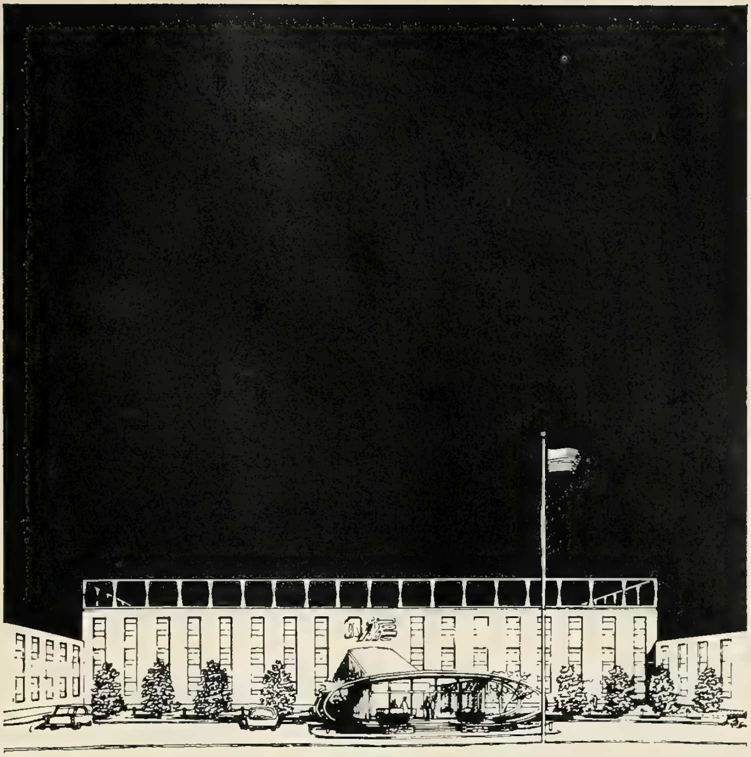
- **Low-noise-front end for transponder**—Goddard is quite interested in developing tunnel diode front ends which would reduce the noise figure (now about 11-14 db) in the signal. If this figure could be brought down to 3½ or 4 db, this would reduce the necessary ground power by a factor of four or more and would cut costs substantially.

- **Other advanced programs**—Other Goddard projects include the study of techniques for antenna beam-forming and beam-steering. The phased-array antenna designed for *Advanced Syncom* is one form only, and others may be promising, Mackey said.

NASA is exploring the state of the art for devices—perhaps solid-state—to generate microwave energies. Traveling wave tubes have an efficiency of only 25-30%, Goddard scientists say.

Continued development also will be supported in the search for new ways to provide multiple access to the communications satellite.

- **Passive satellites**—While NASA has no flight program for a follow-on to *Echo*, continued advanced work is supported. Work is continuing on lighter materials—perhaps mylar with holes in it and a decomposable bag inside it to inflate it. So far, however, no material has been found with the proper strength and decomposition to act as the inflater.



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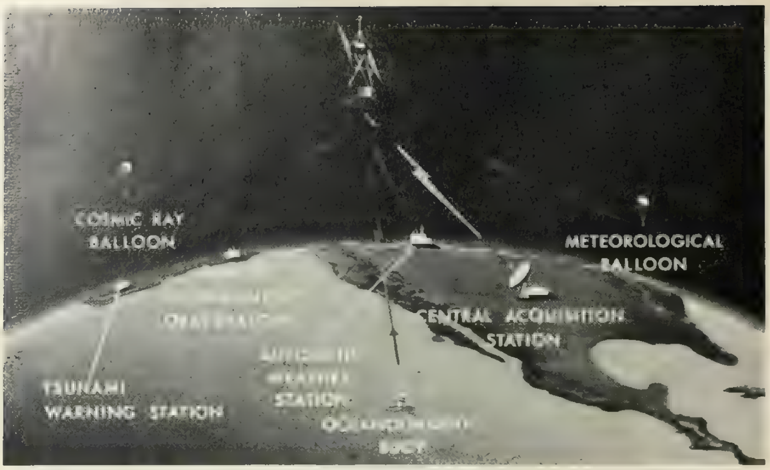

DATA COLLECTION by satellite in polar orbit. Satellite would interrogate by memory from variety of ground stations to be read out at a command station.

OTHER POSSIBILITIES

With meteorological and communications satellites just beginning to pay their own way, NASA already is looking ahead to other satellite applications which may provide considerable industry opportunity in the next decade.

Two possible new satellites are now in the study phase, and advanced thinkers already have four others in the files. None have program approval, but they represent concepts now being considered by NASA and possible government "users."

- **Navigation**—Several civilian government agencies already have shown interest in a satellite which could provide highly accurate and detailed information to aircraft, or sea vehicles with a minimum of equipment or trained crew. Two feasibility study contracts by Westinghouse and a team of General Electric/Univac will be completed in December. Detail design and development may come in FY '66, taking about two years.

Advanced applications director Alton B. Moody says the selling point of such a satellite is that it could be used for traffic control purposes, or for rapid search and rescue. The entire satellite system would have four parts: 1) the satellite itself, which would act as a data link and reference point; 2) user ship or aircraft; 3) a small number of fairly elaborate ground stations equipped with computers; 4 from 12-24 unmanned ground beacons.

Each user would have an "address code," which would indicate the type of craft and service needed. Upon embarking, he might press a button giving this code, and get a fix to 1/10 sec. to check. The stationary ground beacons, some of which could even be installed at the control station, would give a signal every half-minute to the satellite to position it.

By analyzing by computer data relayed by the satellite from the aircraft or ship, the ground station could provide traffic information with wide enough coverage and speed to prevent supersonic craft from collision courses.

Search and rescue operations would be greatly improved, since it would be known instantaneously as soon as there was no answering signal. The nearest craft would be located instantly and directed to the scene. In fact, Moody suggested, a ditching aircraft actually could be vectored toward the nearest vehicle.

All traffic could be guided away from weather situations by the command stations. NASA said it hoped to get the cooperation of the FAA, Maritime Administration, Coast Guard, Coast and Geodetic Survey and the Geographical Survey in the development of such a system. The user agencies would probably operate and develop the ground stations.

Moody described the satellite as perhaps being roughly oriented to the Earth (within 5-10°) at an altitude from 1,000-12,000 miles (although 6,000 now looks best). It probably would be powered by solar cells, although isotopic power would be a possibility.

- **Data collection**—A somewhat simplier concept now in feasibility study contract to Sylvania is a satellite which would orbit in a polar orbit at several hundred miles altitude, and interrogate by memory a number of information-collecting ground stations. These might be buoys, balloons, or equipment placed on geographically inaccessible places such as icebergs. These would be equipped with sensors to get such data as temperature, pressures, wind and sea condition. At high latitudes, this information would be rea
out at a command station.

While possible users have show
great interest, Moody said, no one ha
come up with specific plans for sensor
and platforms. Hence NASA may b
required to coordinate new develop
ment.

Goddard Space Flight Center no
is looking at a simple black-box experi
ment to put on an existing satellit
such as *Nimbus*. This study may b
completed in a couple of months, an
the package might be developed for th
third *Nimbus*.

The experiment would locate on
ground or sea information point, co
lect data, and transmit it to a contr
station. This would demonstrate th
feasibility of the idea, and give an ide
of what kind of equipment would b
needed.

Moody also pointed out that th
functions of this and the navigatio
satellite could be combined.

- **Potpourri**—Among the other sa
ellite ideas which have not yet bee
examined in depth but are in NASA
files:

—It appears possible that hig
resolution photography at different o
tical frequencies could be used to dete
mine the nature of the material phot
graphed—such as types of trees an
minerals. This technique might be use
to survey in detail the Moon and othe
planets.

—It is conceivable that some man
facturing processes could be conducte
less expensively—or only—in spac
with its high vacuum, radiation, sol
power supply and weightlessness. Is
tope separation is one example. Th
is an extremely long-term idea, Mood
emphasized.

—High-resolution cameras could b
employed by open agencies such as th
Arms Control Agency. Observatio
could be conducted overtly and ma
available to all parties concerned.

—A complete survey of the inte
changes in the Earth's environme
might be useful for prediction or u
derstanding of changes in the weath
and communications processes. Ho
ever, these interchanges must first b
monitored to determine what occur
and which relationships might be in
portant. The *IMP* program is a step i
this direction, since it goes 85% of th
way to the Moon.

—This office will one day be co
cerned with investigating what fun
tions in space man can perform bett
than instruments, in a practical sens
One such study might be to assess th
applications of man in maintainin
nuclear vehicles. However, this respons
mility lies now with the Offices
Manned Space Flight and Biotechnolog
and Human Affairs.

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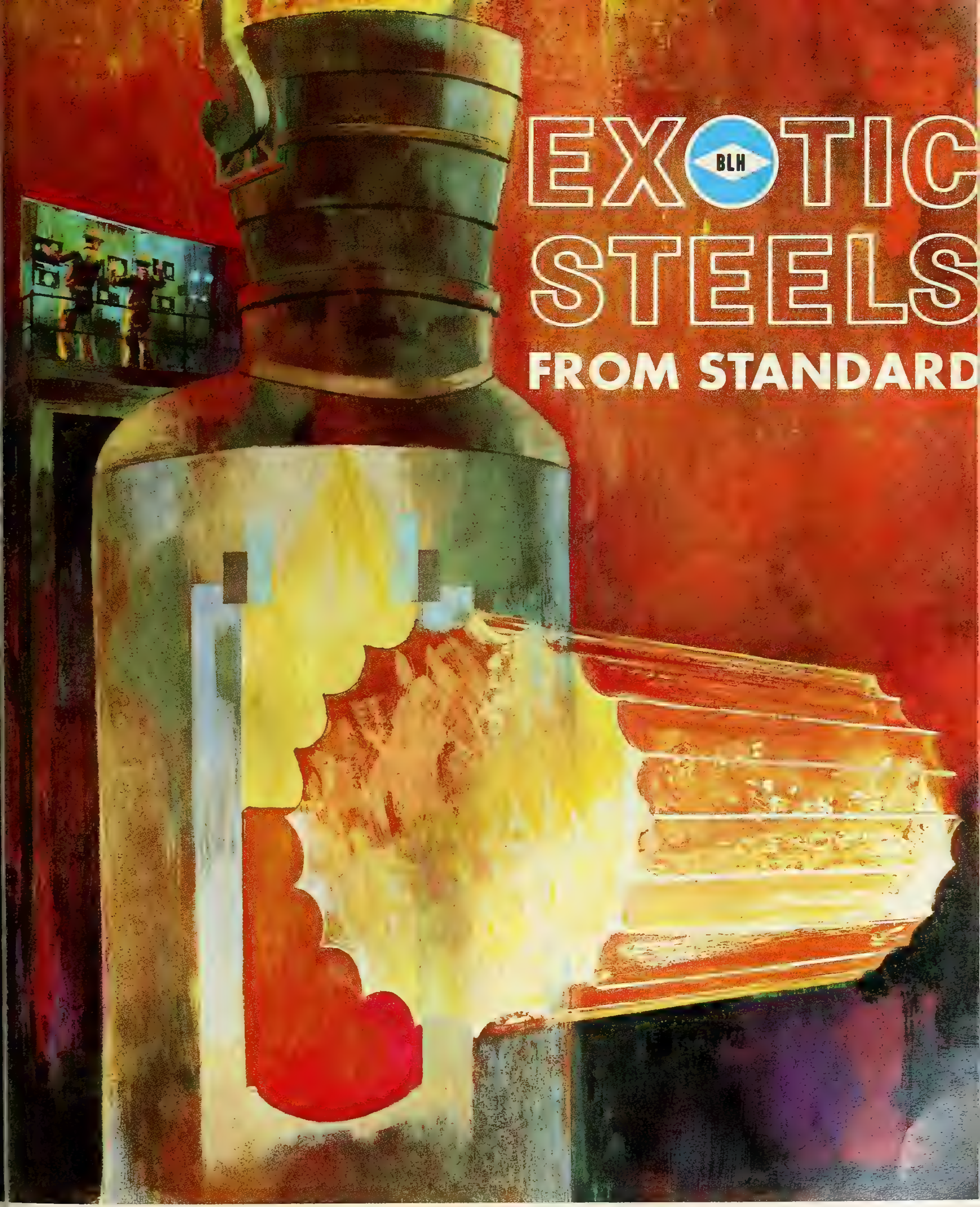

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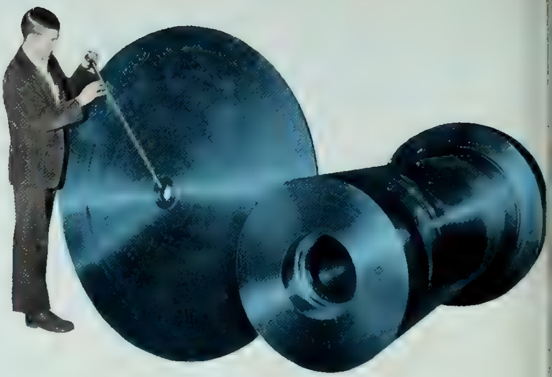

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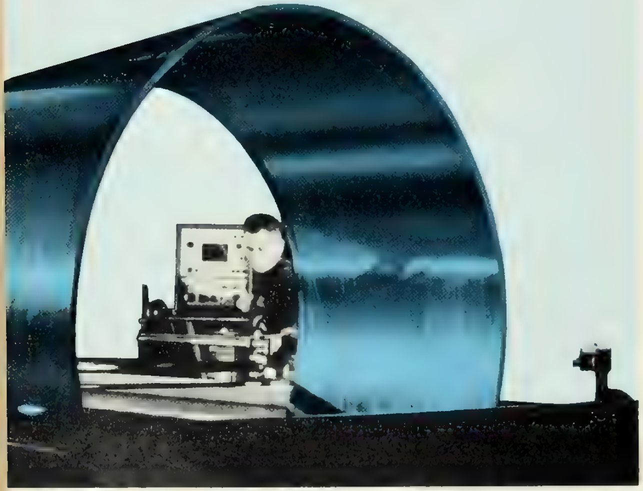
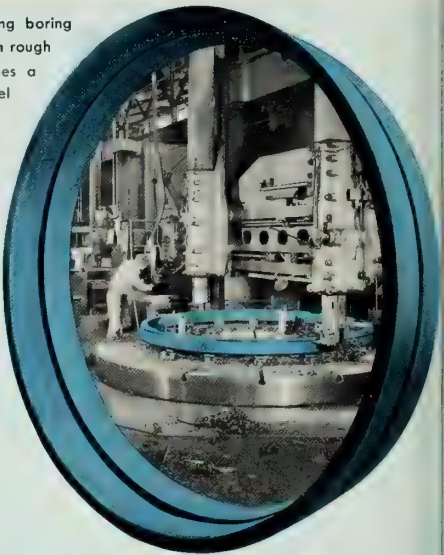


Modern 14-ft. swing boring mill viewed through rough rolled rings machines a huge weldless steel bearing ring.



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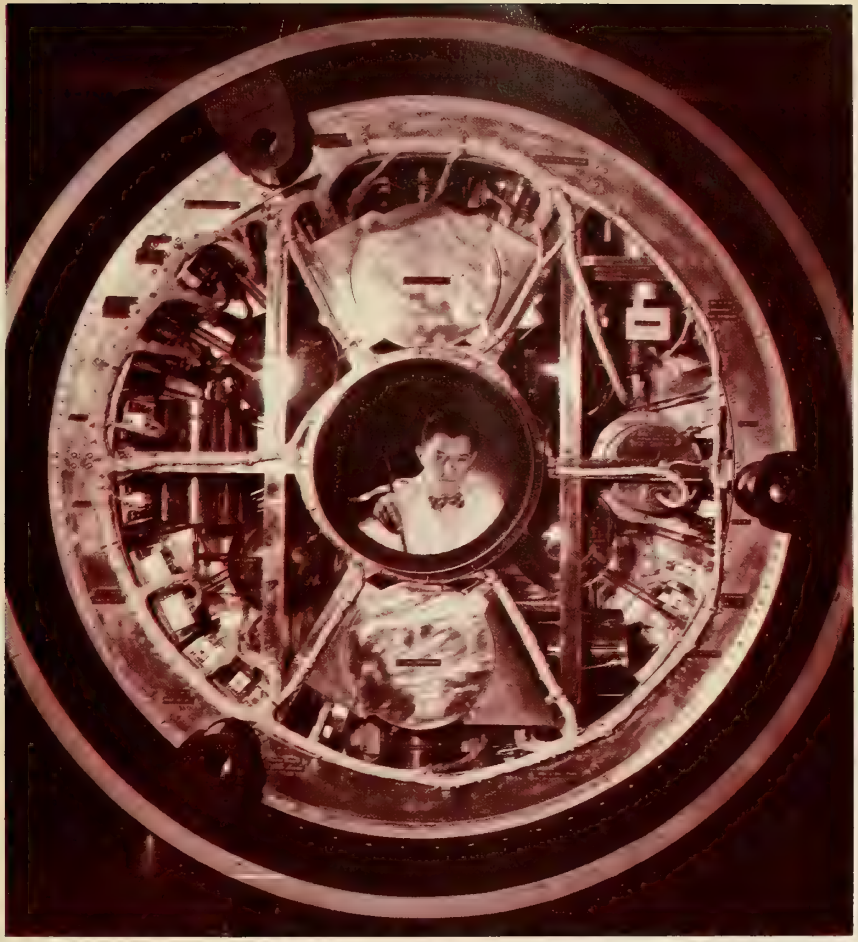


BOTTOM VIEW of mockup of Republic Aviation Corp.'s Advanced Orbiting Solar Observatory.

Scientific Satellite Projects Hit by Cuts in FY '64 Budget

CONGRESSIONAL CUTS in the Fiscal 1964 NASA appropriation bill will reduce the number of follow-on satellites in the Scientific Observatory programs.

The slashed funding probably will also delay a start on the new Radio Astronomy Observatory until Fiscal '66. Originally, space agency officials wanted to do some component work in the current year, with hardware development funding scheduled for FY '65.

A large share of the Office of Space Sciences' original $810-million budget request was slated for continuance of the broad research and scientific satellite effort. Of this total, more than $420 million was to be used for OSS projects in the fields of geophysics, astronomy, biosciences, associated university research, and launch-vehicle development.

Individually, these research projects do not represent heavily funded tasks and they lack the glamor of the larger planetary or manned space flight programs, one space official said.

Congress, however, treated the programs very well. It cut the authorization request by only about $20 million —to just under $400 million. The later reduction in appropriations—to just under $5.2 billion for the agency as a whole—probably will mean only another cut of $40 to $50 million, according to NASA officials.

Nevertheless, even this reduction will cut the number of spacecraft planned for the heavy observatory spacecraft series. For example, the *Orbiting Astronomical Observatory* series had scheduled three follow-on spacecraft; this has been cut back to one.

In any event, NASA officials told MISSILES AND ROCKETS that the present development and launch schedule for the observatory-type satellites will be maintained if at all possible. Other scientific satellite programs surely will suffer delay, however, in accordance with the expected reduced funding.

The *Orbiting Geophysical Observatory* program has already undergone a limited stretch-out, and NASA announced early this month that it is considering employment of only a single *Meteoroid Detection Satellite* if the first spacecraft proves successful.

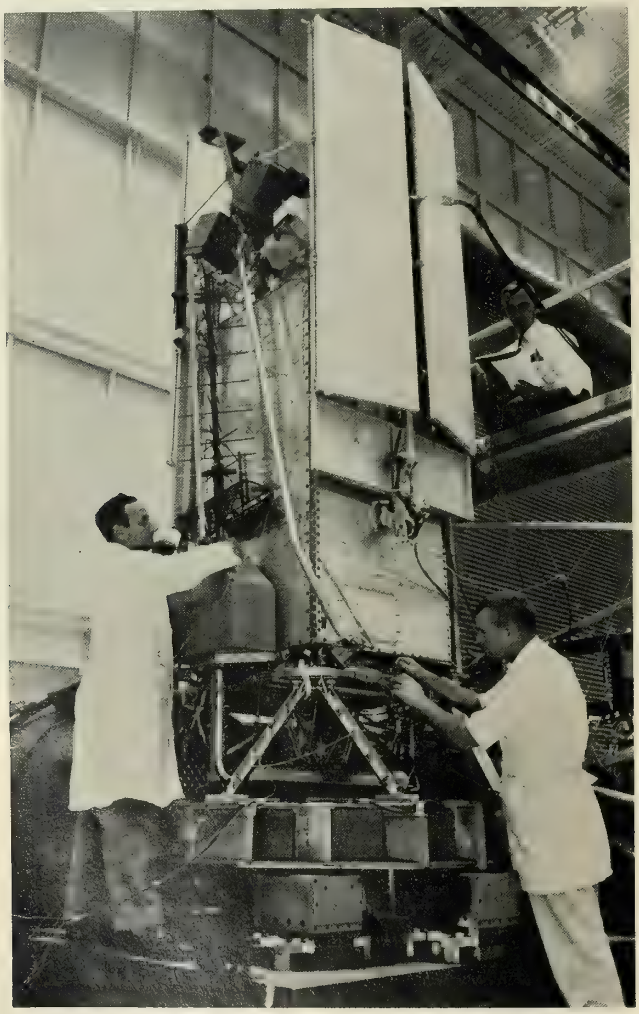
Additional cuts will be applied to those programs to which NASA is not firmly committed—particularly to those having well-defined R&D decision points.

● **Wish-basket full**—Despite the impending cutback, space agency officials outlined for M/R a long list of future space vehicle needs during the next 15 years.

Within the 1964-1970 time period, the recently awarded *Advanced Orbiting Solar Observatory* will extend existing solar radiation studies. The next large observatory planned is the *Radio Astronomy Observatory* now being studied in-house by NASA, primarily at Goddard Space Flight Center. No other observatory series is currently planned.

A Langley/MIT *Scout*-launched solar-probe series has been initiated, and the Ames Research Center solar probe study effort is nearing completion.

Also out of Langley will come a new *Lunar Orbiter*. Source evaluation (from seven bids) and contractor selection is expected early next month. (Contract value will be about $20 million.)



ORBITING Geophysical Observatory shaker-tested at prime STL.

Other projects sitting in the NASA wish-basket include:

1) Galactic probes, including a Sun-orbiting observatory;

2) *Advanced Interplanetary Monitor Probe;*

3) *Advanced Orbiting Astronomical Observatory,* capable of carrying optics larger than the present 36-in. sy tem—possibly as large as 100 or 20 in. optics.

● **Solar studies**—The Internation Year of the Quiet Sun beginning ne year will intensify studies of the Su throughout the world.

Of particular interest to NASA the effect of solar flares on space con munications, and radiation effects ar hazards in outer space and in the Va Allen belts.

OSO-1 already has accumulate nearly 2,000 hours of data on sol X-ray and ultraviolet radiation. Hov ever, according to Space Science D rector Homer E. Newell, the pointir precision of *OSO-1* is not good enoug to permit a concentrated study of th cellular structure of the Sun's surfac Such a study, he said, is essential to un derstanding the occurrence and cha acteristics of solar flares.

Funds have been requested for F '64 to begin development of *AOS* which will have an improved pointir capability. Also, the present *OSO* sy tem is limited to pointing only two in struments at the Sun at a given tim Future observatories, he stated, mu be able to point a large number of in struments continuously at the Sun's su face.

● **Improved OSO coming**—Repul lic Aviation Corp. received a $5.5-mi lion contract last July from Godda to complete a one-year detailed desig for the *Advanced OSO* spacecraft, lea ing to a follow-on contract for fligh test models next year.

The new observatory will be ab to obtain extremely fine measuremen of the solar disc through a field of vie extending to about 10 degrees. Also, will provide 5-arc-second pointing a curacy that will permit nearly 400 o servations across the Sun's diamet during one pass.

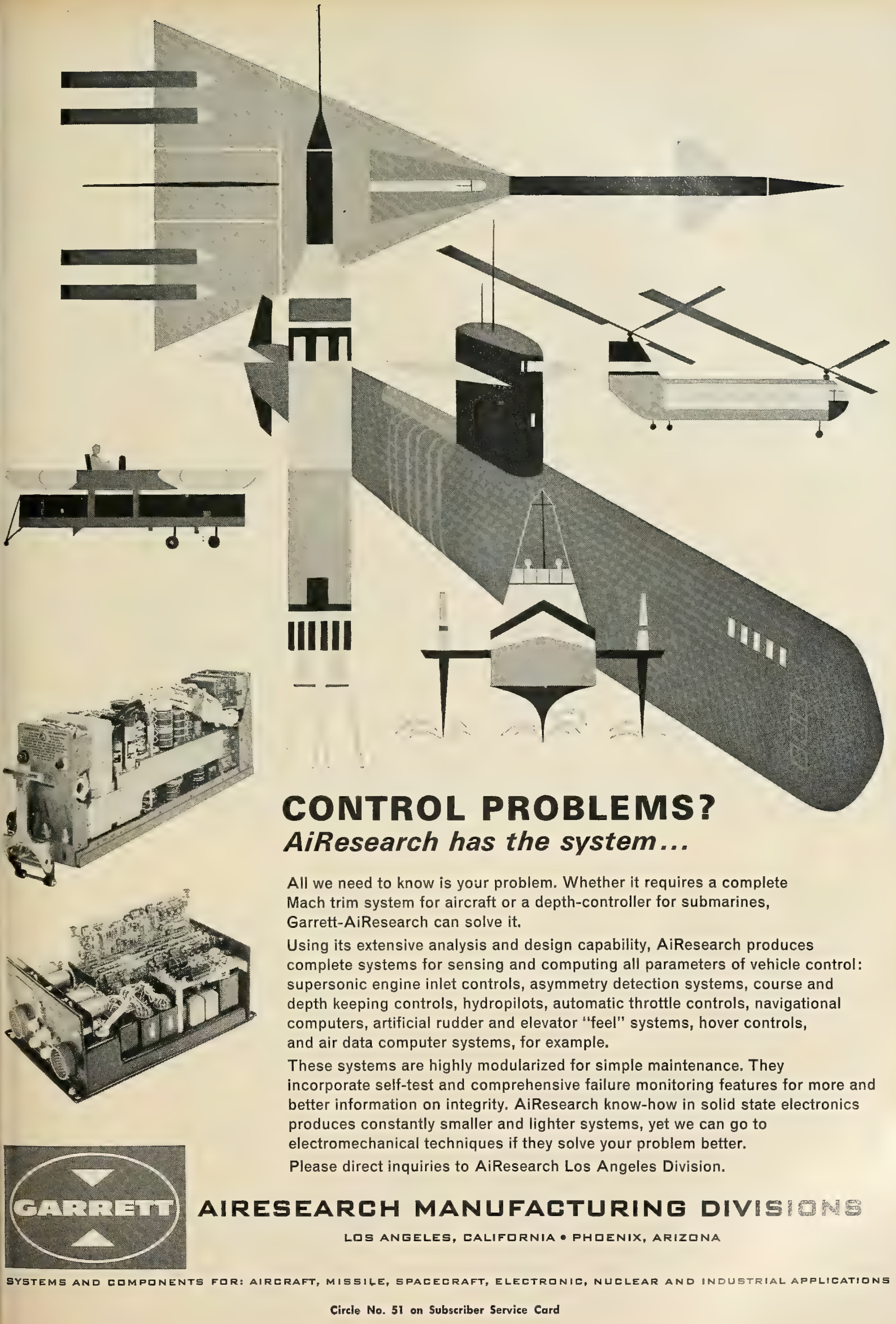
Such a mass of data will perm significant spectral analyses of indivi ual sunspots.

Present plans call for launching tw *OSO's* a year until 1967, then four year to coincide with the period of ma imum sunspot activity.

Interplanetary radiation and fie variations resulting from solar flar will be studied by two additional spac craft: the *Interplanetary Monitor Sate lite (IMP)* and a *Pioneer*, which will launched next year.

● **OAO still due '65**—Hardware d velopment by prime contractor Grun man Aircraft Engineering Corp. for th three presently planned *Orbiting Astr nomical Observatories* reportedly progressing on schedule. Trouble ma be developing on this program with th experiments.

First launch is planned for 196 Four Smithsonian 12-in. telescopes w



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be carried to map the sky in the ultraviolet range.

Other optics under development include four 8-in. and one 16-in. telescope (by the University of Wisconsin), a 36-in. Goddard telescope and a 32-in. Princeton University telescope.

Launches will be made at 6 to 9-month intervals.

The first 3,600-lb. *OAO* will be placed in a nearly circular 500-mi. orbit.

By the nature of the *OAO* mission, pointing requirements are unusually severe. The ultimate goal (to be achieved by *OAO-3*) is an accuracy of 0.1 second of arc.

In addition, the ultra-precise attitude-control system and the very precisely aligned telescopes must be able to withstand the heavy vibration and thermal cycling during launch and early flight through the atmosphere.

The *Pioneer* follow-on series of deep space probes will permit the monitoring and study of particles and fields out 50 to 90 million mi. from Earth. By launching two probes—one ahead of and the other trailing the Earth—plus several Earth satellites, a very large segment of the solar sector can be observed.

This new series is expected to be carried out between 1964 and 1967.

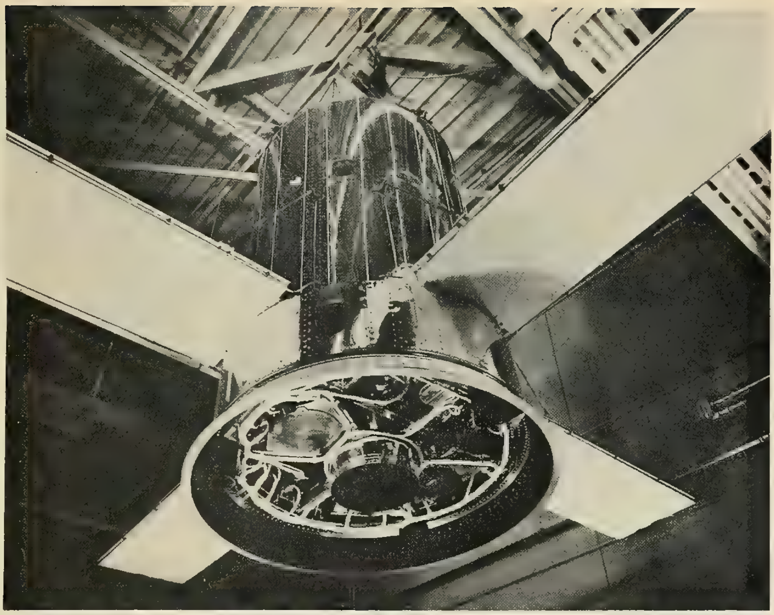
- **Solar wind probers**—To study the effects of solar wind fluctuations on the Earth's magnetosphere during the next few years, *IMP* and *EOGO (Eccentric Orbiting Geophysical Observatory)* will obtain measurements out to 150,000 and 60,000 mi. respectively. The first *OGO* launch, according to NASA officials, has been delayed until next summer. Thereafter, about three per year will be launched.

The highly eccentric *(EOGO)* and nearly circular polar *(POGO)* orbiting *OGO* satellites will each carry a great number of different experiments, providing integrated simultaneous measurements of many geophysical and solar phenomena. In time, analyses of the data obtained from the satellites should better explain a variety of Earth-Sun relationships.

The first *EOGO* will carry 20 correlated experiments, and 19 will be aboard the second craft. Measurement instrumentation will account for 150 lbs. (Total satellite weight is just over 1,000 lbs.)

Throughout the full 11-year solar cycle, at least two operating *OGO's* will be maintained in different orbits.

- **Ionospheric studies**—*Alouette (S-27)*, the Canadian swept-frequency ionospheric topside sounder, has had the best test and flight record of any Free World scientific satellite, according to Edgar M. Cortright, deputy director of *OSS*. After well over a year of orbital operation, he disclosed, the system is working perfectly and has not even employed any of its redundant systems.



VASTLY IMPROVED pointing accuracy is expected from Advanced Orbiting Solar Observatory. The $5.5-million, one-year Republic contract covers detailed design.

As follow-on to its first spacecraft, Canada will produce two more—*S-27A*, similar to *Alouette*, and *ISIS (International Satellite for Ionospheric Studies)*, which will be a polar-launched ionospheric monitor.

In addition, *S-48*, the U.S. fixed-frequency topside sounder, is scheduled to be placed in orbit in 1964.

To further dissect the near-space volume, the *Atmospheric Structure Satellite* and sounding rockets will be used. Rocket launches during 1963 will total more than 100, compared with 78 in 1962, Cortright said.

The British *UK-2* satellite will be launched to further extend ionosphere studies.

- **Biosciences grow**—By late 1964 or early 1965, it is expected that the first of several biological satellites will be flown. These will be recoverable vehicles, each carrying several experiments in fundamental biology.

NASA hopes to complete final contract negotiations (with General Electric) by the end of this year.

The Biosatellite program is a logical extension of previous studies carried out by balloon-borne observatories (the Princeton Stratoscope series) and upper-atmosphere sampling by means of research rockets.

By using a recoverable satellite capable of re-use once a month, a continuing study can be made of the life forms existing in the Earth's upper atmosphere. Also, infrared studies can be continued to determine presence of life-like organic molecules on Mars.

- **Responsibility**—In general, under NASA's present Space Sciences organization, the scientific satellite programs are directed by either Goddard Space Flight Center or Ames Research Center. Goddard manages all of the *Explorer, Monitor* and *Observatory*-type vehicle programs. Ames is responsible for the renewed *Pioneer*, the new *Biosatellite* programs, and for the solar probe study.

- **IMP**—The first launch of the *Interplanetary Monitoring Platform* satellite is now scheduled for early in December.

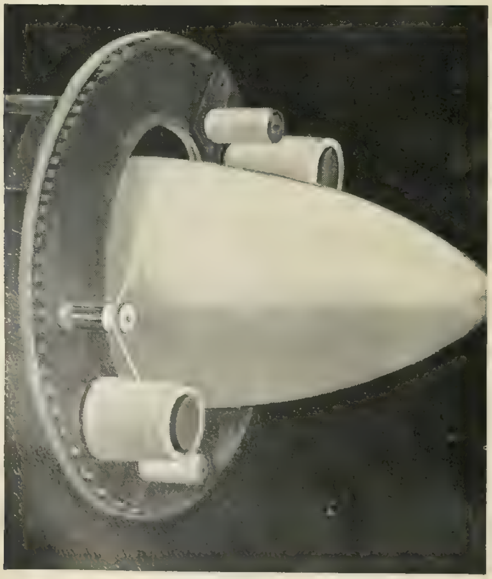
The 128-lb. satellite holds 35 lbs. of experiments and is designed to measure magnetic fields, cosmic rays, and solar winds in interplanetary space.

One of the key objectives of the *IMP* series is to study charged particles, radiation emanating from the Sun and sources beyond the Sun in interplanetary space over a period of relatively quiet solar activity through the more active phases, thus covering a significant portion of the 11-year solar cycle.

Its distinguishing feature is the manner in which its magnetometers have been mounted to avoid interference from the weak magnetic field generated by the satellite itself. Protruding from the top of the satellite like a one-sided dumbell is a rubidium vapor magnetometer mounted on a boom that telescopes out to a distance of six ft. after orbit is achieved.

IMP's orbital apogee will be 173,000 mi.; its perigee, about 125 mi. ■

News Briefs



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AEROSPACE NEWS from Dow Corning

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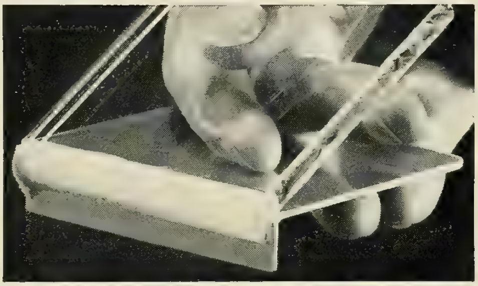

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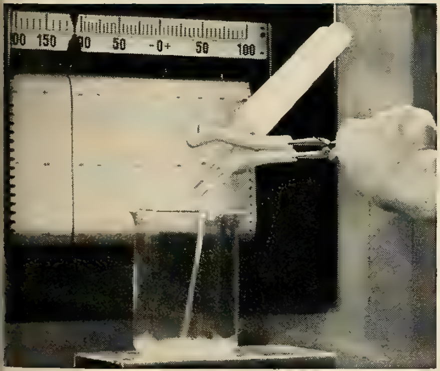

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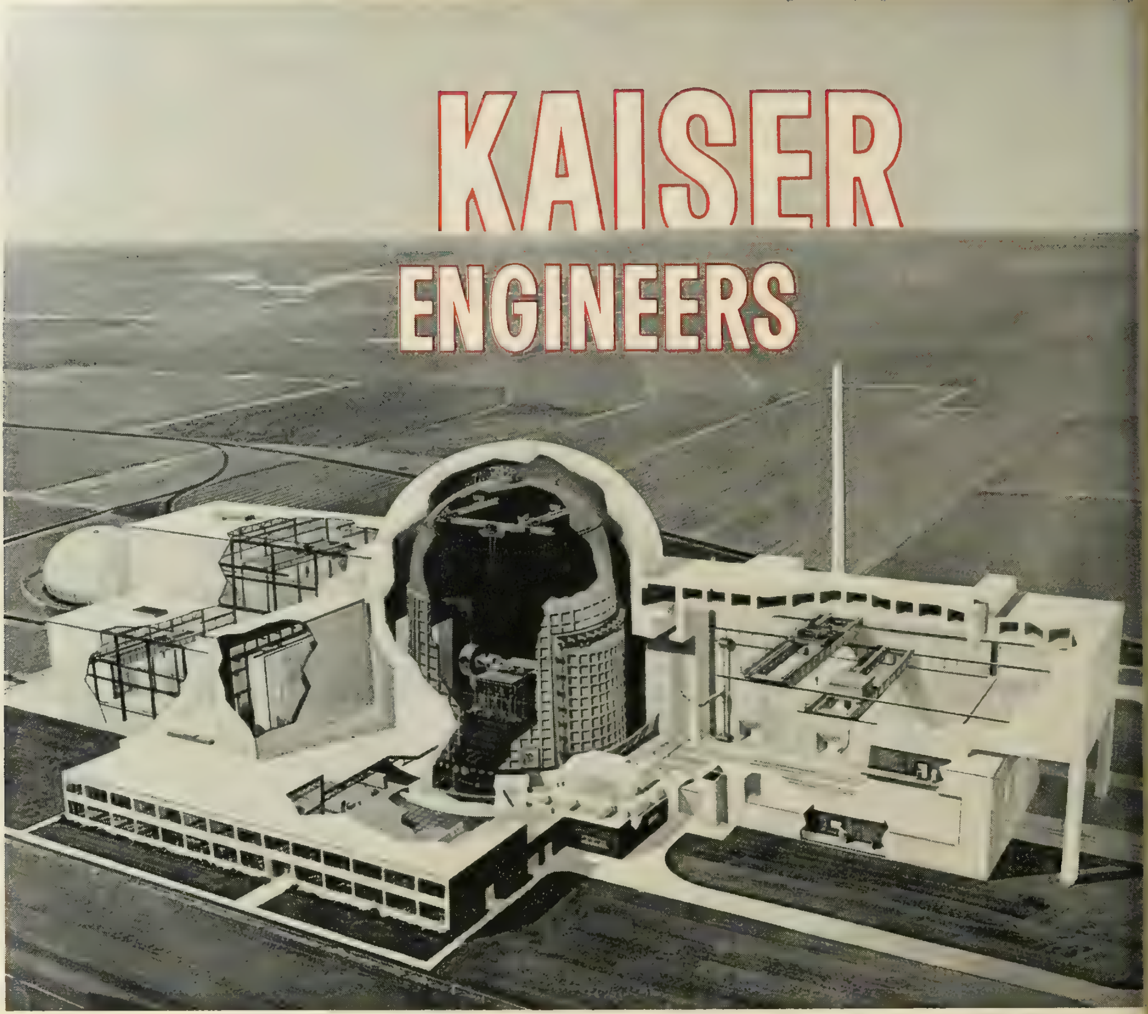

Designs... for NASA

NASA Lewis Research Center's Space Propulsion Facility is designed to simulate outerspace environment, including high vacuum, cryogenic temperatures, and solar radiation. The facility incorporates capability for testing full-scale nuclear and non-nuclear spacecraft, including nuclear power generation and electric propulsion systems. Kaiser Engineers' assignment — feasibility study, design criteria, preliminary nuclear hazards report, detail design, construction specifications, critical path scheduling. Kaiser Engineers is proud to be a member of the NASA team developing this advanced facility. KE also numbers among its clients the AEC, Air Force, Army Corps of Engineers, Navy Bureau of Yards and Docks, and leading aerospace industry firms.

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Greater Emphasis on Mission In Large Launch Vehicle Concept Studies

Fluorine technology pushed for high-energy upper stages in medium launch vehicles; big vehicle development plans are nebulous; creative thinking sought for Advanced Nova

NEW HIGH-ENERGY ENGINES and a re-orientation of the *Nova* launch vehicle study programs highlight current NASA plans in the areas of advanced launch concepts—both manned and unmanned.

Other trends that will influence future launch vehicles are:

—A drive to capitalize on current fluorine technology.

—A possible multipurpose Mission Module stage for *Saturn 1B* and *Saturn V*.

—A search for more creative extrapolation of technology in the *Advanced Nova* launch systems.

In the high-energy field, NASA planners hope to move into complete fluorine/hydrogen propulsion systems within the next two years. Studies and analyses of vehicle life and future unmanned mission requirements keep pointing to fluorine as the final answer.

• **Dollars & missions**—The main problem here, as in every future concept, is funding and missions. The final Fiscal 1964 budget will be under that minimum promulgated by the space agency as necessary to keep the *Apollo* program on the track.

There is little or no optimism for higher funding levels in the next several years. One proposed fluorine concept is aimed at a 40,000-lb.-thrust upper-stage propulsion system, but the costs through development and facilities is conservatively pegged at $300 million.

A low-level approach to fluorine usage is already under way with the fluorine/LOX modification to the *Atlas* booster. This will provide a significant increase in performance (see charts) for a relatively low cost. The Air Force is showing some interest in this program.

The major target in medium-sized launch vehicles is package velocities in

CURRENT NASA LAUNCH VEHICLE PROGRAMS

VEHICLE	STAGES OR ENGINES	PROPELLANT	THRUST (1,000 LB.)	MAX. DIA. (FT.)	HEIGHT (FT.)	PAY-LOAD (LBS.) 300 NMi	PAY-LOAD (LBS.) ESCAPE	MARS/VENUS	FIRST NASA LAUNCH
SCOUT	1. Algol II-A	Solid	86	3.3	72	240	—	—	1 July '60
	2. Castor I-E5	Solid	64						
	3. Antares X-259	Solid	23						
	4. Altair X-248	Solid	3						
DELTA	1. Thor (DM-21)	LOX/RP	170	8	90	800	100	—	13 May '60
	2. AJ10-118	WIFNA UDMH	7.7						
	3. Altair X-248	Solid	3						
THOR-AGENA B	1. Thor (DM-21)	LOX/RP	165	8	76	1,600	—	—	29 Sept. '62
	2. Agena B	IRFNA UDMH	16						
ATLAS-AGENA B	1. Atlas D	LOX/RP	367	10	91	5,000	750	400	23 August '61
	2. Atlas D (sustainer)	LOX/RP	80						
	3. Agena B	IRFNA/UDMH	16						
CENTAUR	1. Atlas D	LOX/RP	367	10	100	8,500	2,300	1,300	8 May '62
	2. Atlas D (sustainer)	LOX/RP	80						
	3. Centaur (Two RL-10)	LOX/LH	30						
SATURN I	1. S-1 (Eight H-1)	LOX/RP	1,500	21.6	125	15,000	—	—	1st Stage 27 Oct '6[illegible] 2nd Sta[illegible] 4th [illegible]
	2. S-IV (Six A-3)	LOX/LH	90						
SATURN IB	1. S-IB (Eight H-1)	LOX RP	1,500	21.6	141	28,500	—	—	[illegible]
	2. S-IVB (One J-2)	LOX LH	200						
SATURN V	1. S-IC (Five F-1)	LOX RP	7,500	33	275	220,000	90,000	70,000	
	2. S-II (Five J-2)	LOX/LH	1,000						
	3. S-IVB (One J-2)	LOX/LH	200						
ATLAS D		LOX/RP	367	10	72	—	—	—	[illegible]
TITAN II	1. XLR-87	Storable	430	10	90	—	—		[illegible]
	2. XLR-91	Storable	100			4,000-6,000			

on target with solar power — America scored a space first when the Air Force successfully launched its Project EROS (Experimental Reflector Orbital Shot) and orbited the world's first solar collector. Built by Allison, the collector unfolded itself in space . . . was kept aligned with the sun's rays for about one minute during each orbit by a single-axis sun tracking system. The intense heat built up by the collector provided proof-of-principle data that energy collected in space can operate Allison research devices like the Stirling engine and liquid metal cell. The ability to turn principle into practice is another talent that keeps our other programs . . . including significant aerospace and nuclear projects . . . on target.

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he 50 to 60,000 feet-per-second area. NASA spokesmen call this a reasonable evel, and the propulsion base can handle a large group of unmanned missions. The problem is compounded for advanced planners here by the unknown operational dates of nuclear-electric propulsion systems.

Medium launch-vehicle concepts are difficult to break down into development programs without a good assurance of a long and useful life. The current family of vehicles, up to and including the FLOXed *Atlas/Centaur* will be around or some years to come.

A boost in launch power through high-energy fluorine upper stages may be the earliest route to improved medium-sized launch vehicles. But the approach is hard to justify from a mission tandpoint at the moment.

● **Nova problems**—The entire post-*Saturn V* booster area is treading water and will remain at this stage for at least another three years. There is a good capability in an uprated *Saturn V*—higher thrust F-1 engines and M-1 second stage—for any extensive lunar exploration or early space station propulsion needs.

The main purpose of NASA *Nova* activity now is to keep raising the sights on large vehicle configurations as technology progresses. There is no specific *Nova* system in being—just a series of proposed and changing concepts geared to respond to a high-level decision initiating full-scale development.

● **Mature approach**—The studies give the space agency a chance to thoroughly evaluate its objectives in the area in a manner not possible in past vehicle development programs. Studies are cheap.

The *Nova* area is highly subjective and there are still funded efforts in progress within industry to establish the why, where and when of such a vehicle.

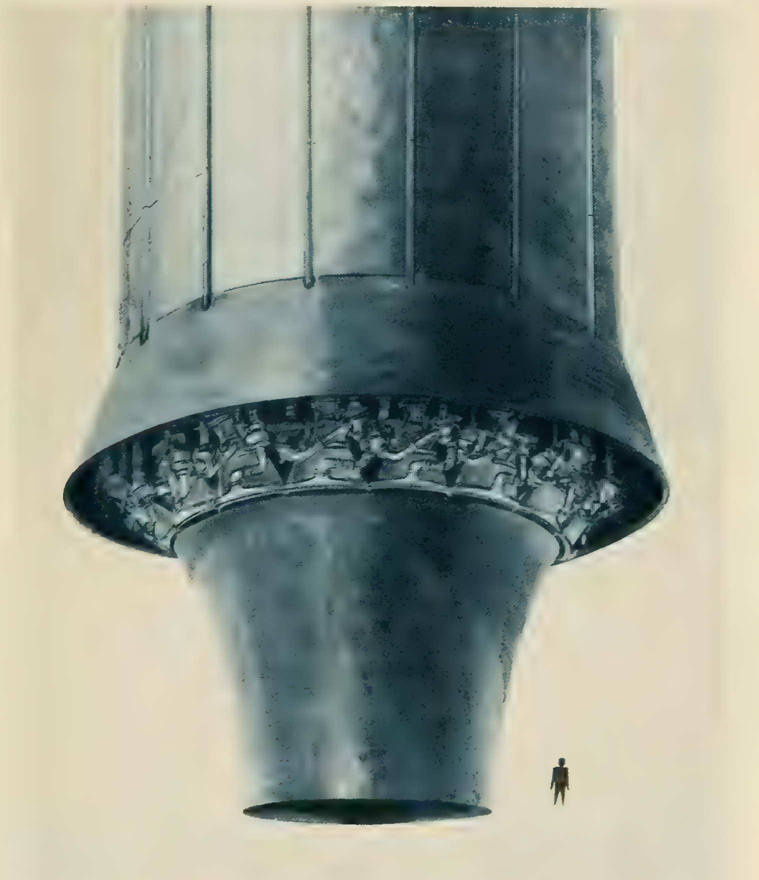
Industry observers do not expect a concrete *Nova* decision much before calendar year 1966, or any significant funding until Fiscal 1967. NASA, of course, does not even speculate on this matter. But the agency is pursuing a broad study program—about $10 million per year—into the technology of the vehicle and its components.

These studies will be re-oriented in the near future. The main objection now forming within the agency's planning sections is the result of the obvious time gap between vehicle concepts and missions. The next two years will see a more mission-oriented flavor to the investigations.

In addition, the one common factor in *Nova*-type missions is long duration—at least a year. This brings reliability and quality assurance into advanced studies. This is difficult enough in current and soon-to-be-operational vehicles.

Another unanswered question is in the choice of the basic booster powerplant—will it be liquid or solid? Marshall experts say this alone will take another two years to thrash out on a study basis.

There is very little enthusiasm for large solids within NASA, but the agency may be forced into making some basic decisions in this area in the very near future—much sooner than the anticipated two years.



POTENTIAL MODIFICATION of M-1 cluster around altitude-compensating nozzle would generate 24 million lbs. thrust in Nova first stage.

● **Paper rockets**—NASA spokesmen emphasize the study nature of *Nova*—and that there is only an intent to define the areas of propulsion and structural vehicle technology where higher technical capability is required.

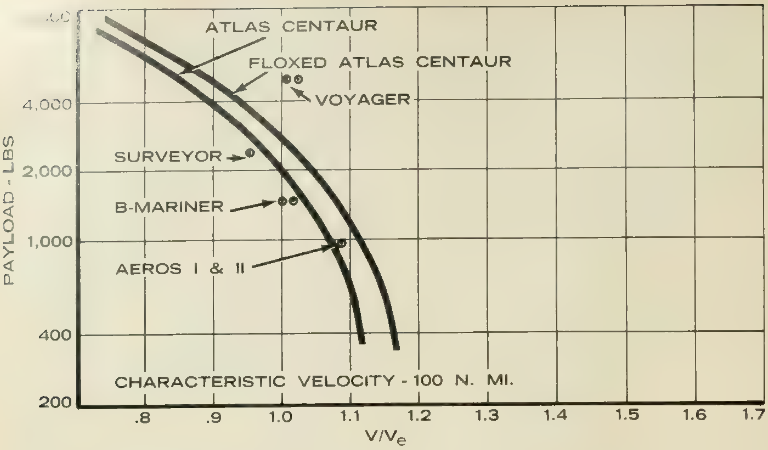
These areas can be broken out of the studies as they progress and programs initiated on a research level to check out the technology. These small projects have the general effect of detailing problem areas to a certain point short of development and then feeding back into the whole *Nova* picture.

In this manner NASA keeps raising the *Nova* technical and industrial base as time goes by, permitting a more intelligent direction to any future *Nova* development decision.

Costs are even more nebulous. Some estimates place a *Nova* development program at between $4 and $7 billion, with each operational vehicle in the $100-million class or higher.

The economics are far more attractive since *Nova* vehicles will be able to place payloads into mission trajectories at a far lower dollar-per-pound level than *Saturn*.

The study approaches to *Nova* are broken into two broad areas—vehicles within reasonable reach of current technology and vehicles outside of this pale. There is a growing trend to con-



ADDING F_2 to Atlas oxidizer system gives I_{sp} increase of 18 seconds. Escape velocity (V_e) is relative to the Earth's surface and equals 36,677 fps.

centrate more on the latter group of concepts.

• **Planning catagories**—NASA has broken large launch vehicles into four general areas for planning purposes:

—*Class I*—The initial vehicles that would make use of current technology and would be the approach if a *Nova* decision were made in the near future. In general, these vehicles would have a 25:1 take-off weight to payload ratio.

The boosters would use 18 or more uprated F-1 engines with LOX/RP propellants or 300-in. diameter solids in a cluster of four. The F-1 combination would provide a total lift-off thrust of 32-million lbs., while the solids would generate about 50 million lbs. at the pad.

The upper stages in both cases would use various combinations of the LOX/LH_2 M-1 engine. The earliest lead time figure for this family is 8-10 years.

Vehicles in this class could easily handle the launch requirements for a manned Mars mission in 1983.

—*Class II*—This group involves some extension of the current state of the art and latest reports indicate that at least two new engines are included. The major innovations expected are higher combustion chamber pressures and advanced nozzles such as either expansion-deflection or plug. In addition, the second stages would be recoverable, although this is desirable in all *Nova* Classes.

The average take-off weight per 1 lb. of payload is 20 lbs.

The Martin Co. has a study contract on this launch vehicle class. Specific aspects of the study include a comparison of LOX/RP and LOX/LH_2 in the booster, the nozzle type and methods of clustering. In addition, Martin is restudying the Class I vehicles to update data and generate more information on the liquid/solid booster choice.

This Class I study may tie up the area completely, leaving NASA free to fund studies in the more advanced classes. There is a trend within the agency's advanced planners to wrap up the studies in this class.

—*Class III*—This group represents

(continued on p. 147)

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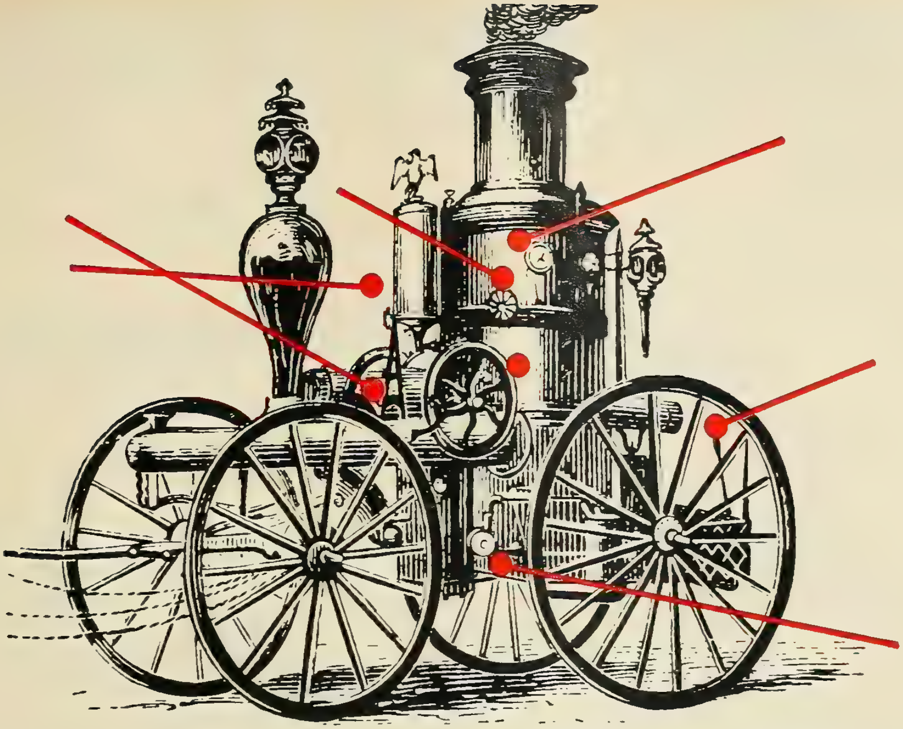

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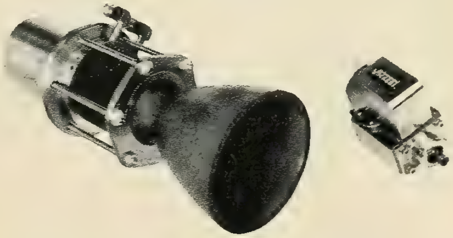

Vickers developments include a bipropellant 60-pound thrust rocket motor (left) and 1-pound thrust bipropellant motor (right). For more details about these and other recent aerospace developments write for Bulletin A-5283 "Harnessing Fluids for Airborne Uses" to: Vickers Incorporated Division, P.O. Box 302, Troy, Michigan.

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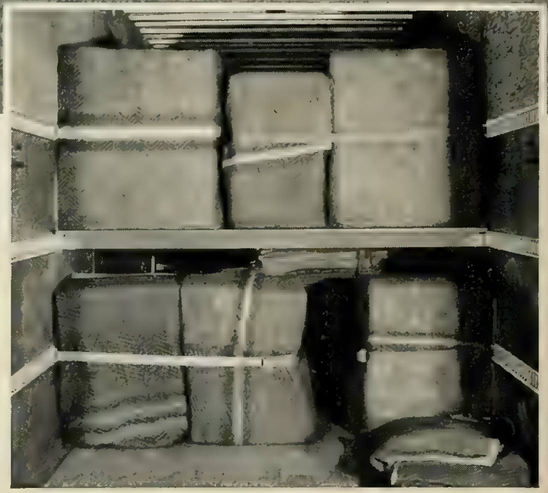

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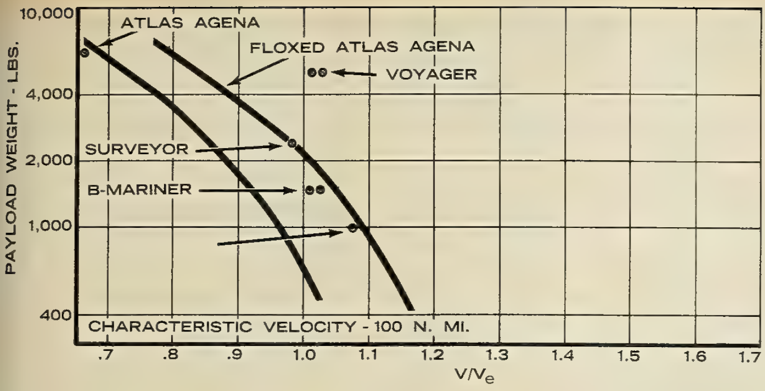


PERFORMANCE increase in basic Atlas booster resulting from mixing fluorine with oxidizer significantly increases mission capabilities of Atlas-Agena.

(continued from p. 144)

the ultimate in straight chemical propulsion. Several concepts have evolved from funded studies here, but there is some indication that NASA will go through this area again looking for "creative thinking" as one spokesman put it.

The first major requirement here is that all vehicles be recoverable. Current concepts include Martin's RENOVA, an air-augmented hydrogen booster; General Dynamics' high-pressure hydrogen vehicle and the Douglas Rhombus concept, an approach using clustered H_2 tankage, which "stage" as they are depleted.

All of these are recoverable and meet the second objective of single-stage-to-orbit capability. Spokesmen at Marshall expect this class will use a highly efficient, 3,000-psi chamber pressure engine. The Huntsville group expects to be funding Class III studies within the next 1 or 2 years.

—*Class IV*—This group covers all advanced launch concepts beyond chemical propulsion. The first nuclear-powered rockets fall into this category. It represents another area where NASA may be inclined to "pull out all the stops" in its in-house and funded studies.

Together with Class III, NASA advanced planners would like to see basic departures from the conventional, current, state of the art. The lead times here are quite long and maximum extrapolation of technology will be expected.

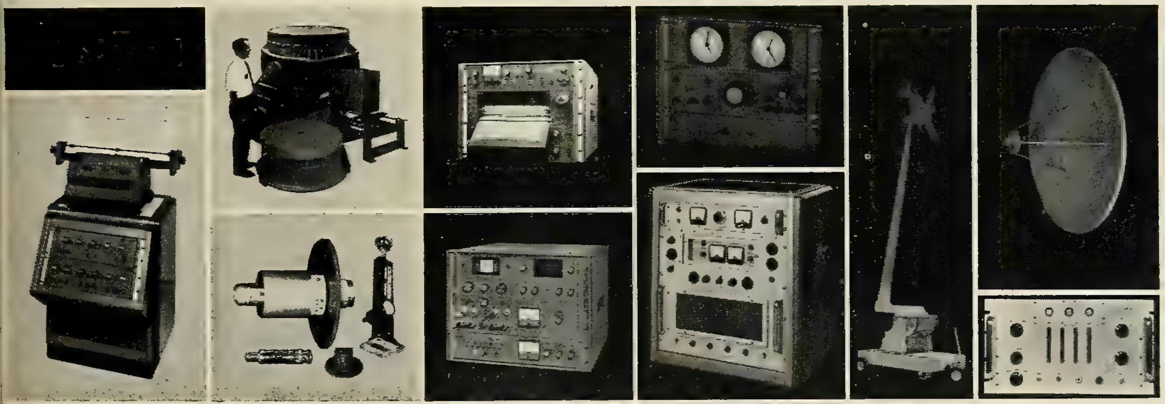
This is the ultimate area of vertical launch vehicles.

● **Immediate considerations**—Launch vehicle experts at Marshall are pushing hard for a multi-mission module as a third stage to the *Saturn 1B* boost system.

About $20 million was requested for this in the center's fiscal '64 budget submitted to NASA headquarters, but the item was not approved. Marshall spokesmen claim eight definite and current missions exist for the multi-mission module stage including certain *Apollo* checkout flights and *Voyager*.

The stage would be "flat" so as to accommodate large payloads, and propulsive power would be supplied by two RL-10 engines.

The Mission-Module could function as a high-speed stage on the *Saturn V* for solar probe missions, handle cargo delivery to the Moon and serve as a braking unit in Mars flights. ■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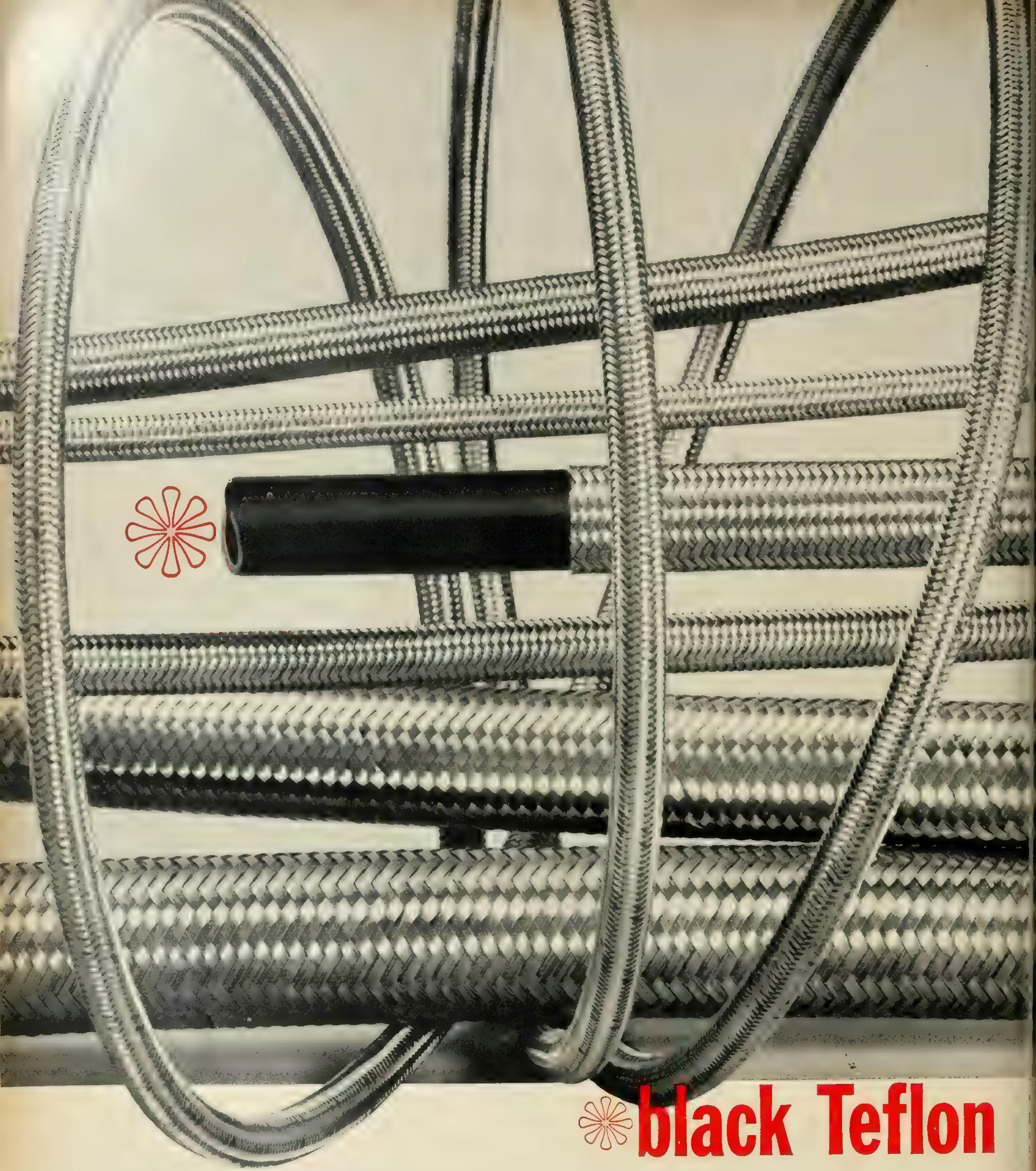

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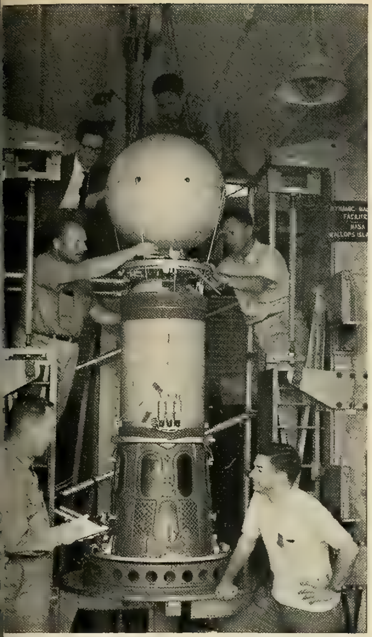
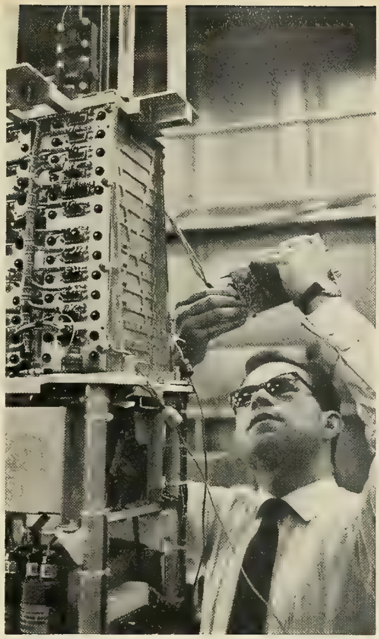
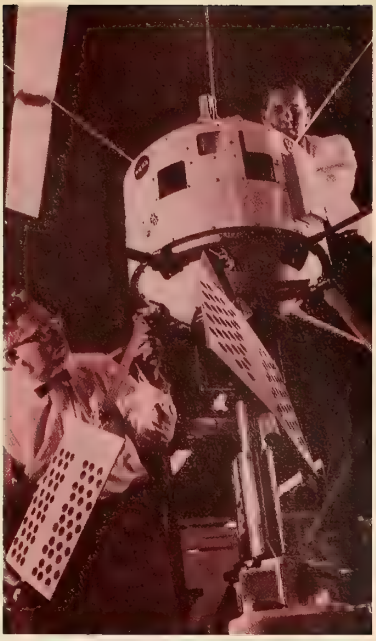


ENGINEERS check second stage of Shotput vehicle and San Marco project payload.



FRENCH technician studies VLF equipment to be used in NASA-CNES probe.



WESTINGHOUSE engineers examine model of S-52 British satellite.

Access to International Brainpower Accrues from Cooperative Projects

NASA-ESRO collaboration, coupled with world-wide programs already under way, appears to be causing Soviets discomfort in their isolation; 65 nations now linked with space agency

A TOP-LEVEL TEAM from the European Space Research Organization ESRO), Europe's consortium for space esearch, is due in Washington next week for discussions with NASA that re likely to affect United States-European cooperative space investigation for years ahead.

Representatives of the 11-nation ESRO organization currently a-building re expected to set forth in detail to NASA the projects they are planning. They also are expected to indicate which rojects they believe should come first, nd to compare notes with NASA across-the-board on respective space research programs.

The meetings will help determine what preliminary projects can be undertaken cooperatively. About six or eight leading ESRO organizers and technical experts are expected to arrive.

On the other side of the globe, Indian technicians trained at Wallops Island, Va., are preparing to launch a series of sodium vapor probes in mid-December, using NASA-supplied *Nike-Cajun* rockets to study upper-atmospheric winds.

The Washington meetings and the shots from India's Thumba range are only two developments presaging a steady increase in international space research cooperation and NASA's share of the resulting benefits.

- **Possible turning point**—The development of ESRO, still to be ratified by all the signatories, is a potential turning point in the Free World's research effort.

The 11 signatories are Great Britain, France, Italy, West Germany, Switzerland, Denmark, Sweden, The Netherlands, Belgium, Austria, and Spain. Norway may sign.

There are signs that prospective cooperative projects between NASA and ESRO, added to world-wide collaborations already in progress, are making the Soviets uncomfortable in their comparative isolation.

Reports have it that researchers in the Soviet-bloc countries would be eager to engage in cooperative space projects, including hardware, if the Soviet Union would let them. The Soviets, however, appear to be sticking to a do-it-yourself system. As one NASA official pointed out, nobody reports to international space-science meetings that they are doing anything significant with the Soviets.

NASA, on the other hand, is currently linked with 65 nations on everything from *Tiros* satellite observations to ground-station operation to actual joint satellite launchings. Forty countries will do signal observations on the *S-66* ionospheric beacon satellite, for instance.

There are agreements or agency-to-agency understandings on experiments with 22 nations.

● **Mutual gains**—"Nobody gets a buck out of it. No dollars go overseas in this program, and it does not require special appropriations," said Arnold W. Frutkin, director of NASA's Office of International Programs. Instead, he said, any NASA expenses are budgeted as part of domestic programs under way.

He stressed that proposals are selected for cooperative projects only if they fit into and serve a useful purpose in NASA's own programs.

But he made it clear that arrangements are strictly *quid pro quo*. In return for launch hardware, or the opportunity to get into the scientific stream by ground observations, NASA gains access to the best brains abroad. NASA, furthermore, shares in important bodies of data in return. NASA officials believe that the "let George do it" approach pays off for both NASA and George.

"We've brought into the program ideas and accomplishments of good scientists abroad," observed Dr. Hugh L. Dryden, NASA deputy administrator. Both he and Frutkin cited the *Alouette* topside sounder, made by Canada and launched with NASA, as a good example of what can be done. The radio propagation package, sent up last year, has sent back such abundant and valuable data that NASA, also pleased with the British *Ariel*, has turned over an important segment of its ionospheric research to the international program.

About four more follow-ons to *Alouette* are under consideration.

NASA selects on a strictly competitive basis proposals from abroad for experiments to be plugged into the format of observatory satellites.

● **Some examples**—Six experiments have been selected for coming observatory satellites:

—An airglow experiment by France's Professor Jacques Blamont, a respected contributor in ionospheric research, to go aboard the *Polar Orbiting Geophysical Observatory* next summer.

—Three British experiments for the "D" and "E" *Orbiting Solar Observatories* to measure solar X-ray emission, helium 2 resonance, and X-ray flux from the Sun's corona.

—A British experiment for the third *Orbiting Astronomical Observatory*, to study X-ray emissions from the stars and nebulae and to obtain information on interstellar absorption of helium and heavier elements.

—A British ion mass spectrometer for the NASA *S-48* satellite next year.

In projects preliminary to launching complete satellites, NASA last month provided two *Aerobee* vehicles for French probes to study ionospheric effects on VLF emissions and to measure electron density. The French team was reportedly pleased with the results from the shots to 122 and 115 miles.

Launch of the British *UK-2* has been delayed until late January by difficulties with the *Scout* vehicle. But NASA and the British are optimistic about the package's capability for measuring radio noise, atmospheric ozone, and micrometeoroid flux.

Planned for 1965 is a joint launch of the French *FR-1* package for VLF measurements and electron density.

● **Interest in probes**—Interest abroad in sounding rockets has been lively. Fifteen nations out of 43 that have sent representatives to Wallops Island have either established or expressed interest in establishing sounding rocket launch facilities of their own.

The Thumba range at the South tip of India, sponsored by the United Nations, is expected to be a valuable site for electrojet investigation because it is on the geomagnetic equator. Next month's sodium vapor experiments will be under United Nations sponsorship, with U.S. and possibly Soviet representatives attending as part of a U.N. team. NASA also has a small sounding rocket program with Pakistan. Pakistanis and Indians, who have had diplomatic contretemps in other fields, are training concurrently at Wallops Island.

Thumba will be involved in the Indian Ocean Oceanographic Expedition next year, in which NASA has invested in by lending two expensive radars. For this, NASA will share the data from what Frutkin described as "the most intensive assault yet on a single weather system."

The British will launch probes from the Maldives, and the Australians will send up others from their west coast.

● **San Marco**—The Italians will fire probes from their platform off Mombasa, Kenya, which will be used in the San Marco program, in which NASA is intensively involved. NASA will provide the *Scout* booster for the San Marco scientific satellite when it is launched into an equatorial orbit in 1965. The Italians will conduct two *Scout* firings in 1964 from Wallops, the first probably in March.

On what is proposed to NASA, and what it gets, Frutkin emphasized that NASA's attitude is "all hard-nosed" for its own programs.

In addition to the fact that no dollars go overseas to subsidize international efforts *per se*, he pointed out that this country actually gets some money back as a sort of bonus.

He said NASA figures that if NASA had set out to do itself what has been done cooperatively in the past fou years, the cost would have been between $30 million and $40 million. In fact, he said, cooperating nations hav purchased about $15 million worth o equipment in this country.

Dryden and Frutkin commented that instead of pressing for United States subsidy for research, nations have been willing and sometimes eager to finance experiments themselves. There has been eagerness abroad to keep up with the scientific times, and not merel among industrial nations.

Teams have gone home from Wallops and set up launching sites fo probes everywhere from Sweden t Pakistan and New Zealand. Sweden Norway and Denmark will build communications dish on their own fo *Relay*, *Telstar* and Comsat.

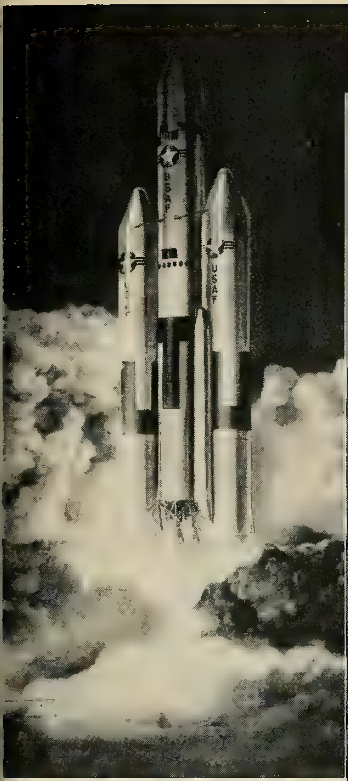
NASA regards the access to good scientific brains overseas as a majo benefit from its international program "We have no monopoly on brains. It good to have them on our side," sai one NASA official.

● **Real estate gain**—But NASA through another phase of its non-contractual agreements, has also gaine access to critical scientific spots on th Earth, such as Thumba, as well as site for vital operations support for programs like *Mercury*. The Swedes share the results of their investigations at fa north Kiruna of noctiluscent clouds.

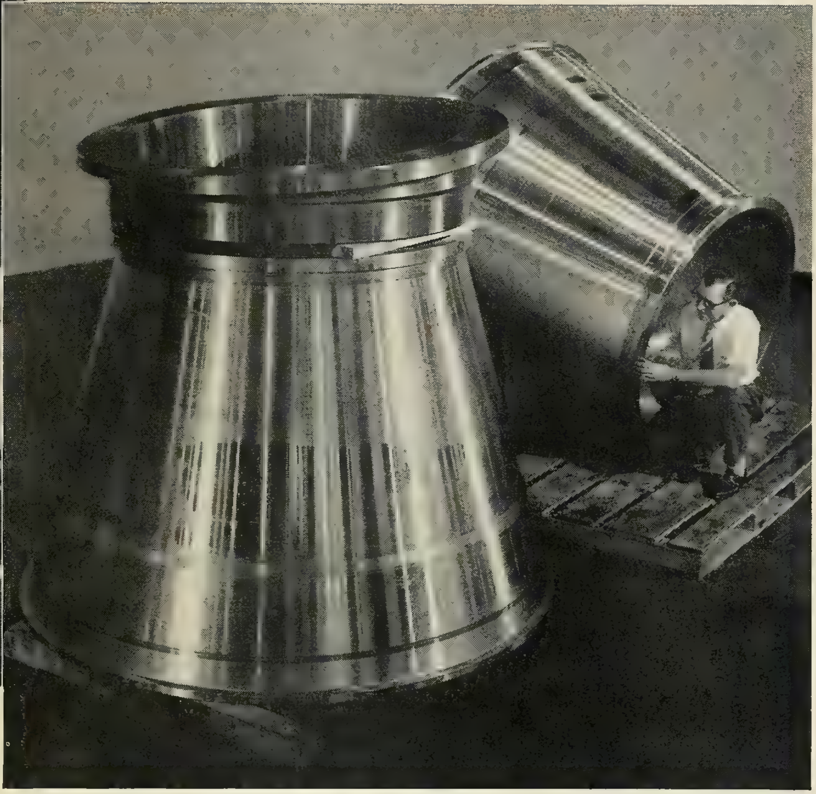
Something may come of an agreement with the Soviet Union for coord nated launchings of meteorological sa ellites, according to NASA official Otherwise there would be twice th number of such satellites.

Looking over the field, Frutkin sai he foresees no "astronomical" increas in foreign space budgets, but that "we'r just opening the lid." Dryden pointe out that France is the only nation spending more on its national space researc program than on its international effor "We're willing to deal with either th national or international" organizatio in any country, he said.

A final dividend from the intern tional program, Frutkin observed, that it demonstrates "in the most co crete way possible the openness of th country's program compared with th of closed societies."



Drawing of Titan III-C Standard Space Launch Vehicle



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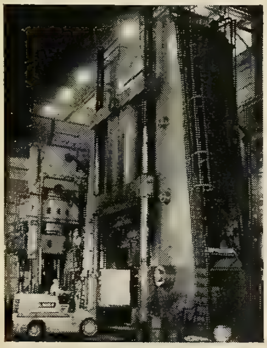

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pre-flight spacecraft evaluation

Photos courtesy of TRW Space Technology Laboratories, Redondo Beach, California.

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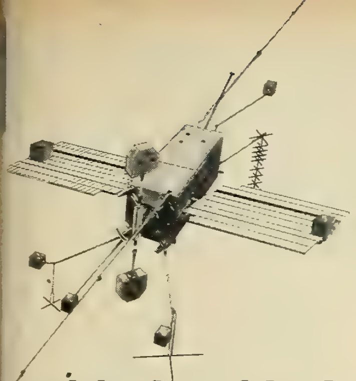

with the aid of a Tektronix Oscilloscope

At TRW Space Technology Laboratories—in extensive preflight tests under simulated space conditions—an engineer uses a Tektronix Type 585A Oscilloscope and dual-trace plug-in unit to check out performance requirements of the new spacecraft receiver for NASA's Orbiting Geophysical Observatory (OGO).

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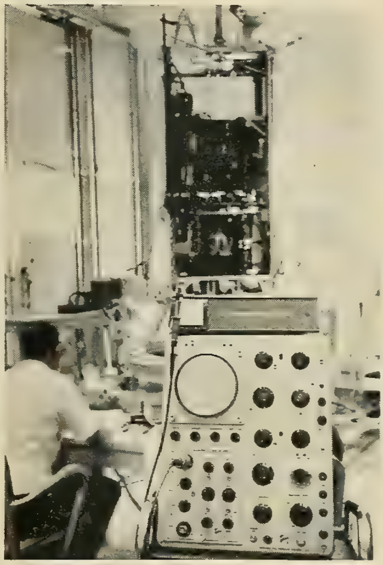

Type 585A Oscilloscope against the background of the OGO Flight I spacecraft at TRW Space Technology Center. This is the actual first of the OGO spacecraft which will be launched from the Cape in 1964.

Testing under conditions similar to those encountered in flight, the engineer monitors equipment performance simply and reliably, keeps an accurate log of performance characteristics, and thus can effectively evaluate operational features of the OGO spacecraft receiver.

For your own high-sensitivity, wide-band applications—either single or dual-trace displays—consider the Type 585A Oscilloscope.

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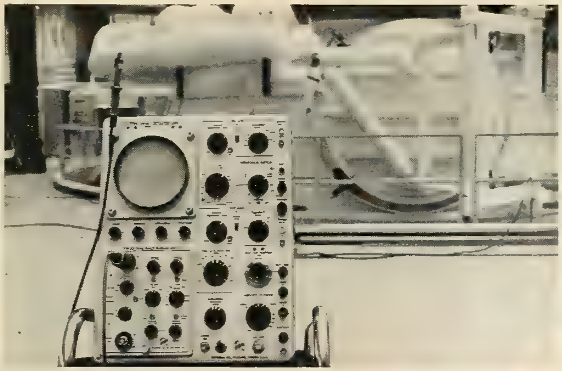
Type 585A Oscilloscope against the background of the Space Chamber. The Space Chamber—heart of the complete space simulation system at TRW Space Technology Laboratories—has an 8-foot diameter personnel access door backed by radiation shield and cryogenic shroud.



Based upon a new design concept, NASA's Orbiting Geophysical Observatory (OGO) features a stock model structure and basic power supply, altitude control, telemetry and command systems. The OGO spacecraft will be capable of carrying into cislunar space up to 50 different experiments on any one flight.

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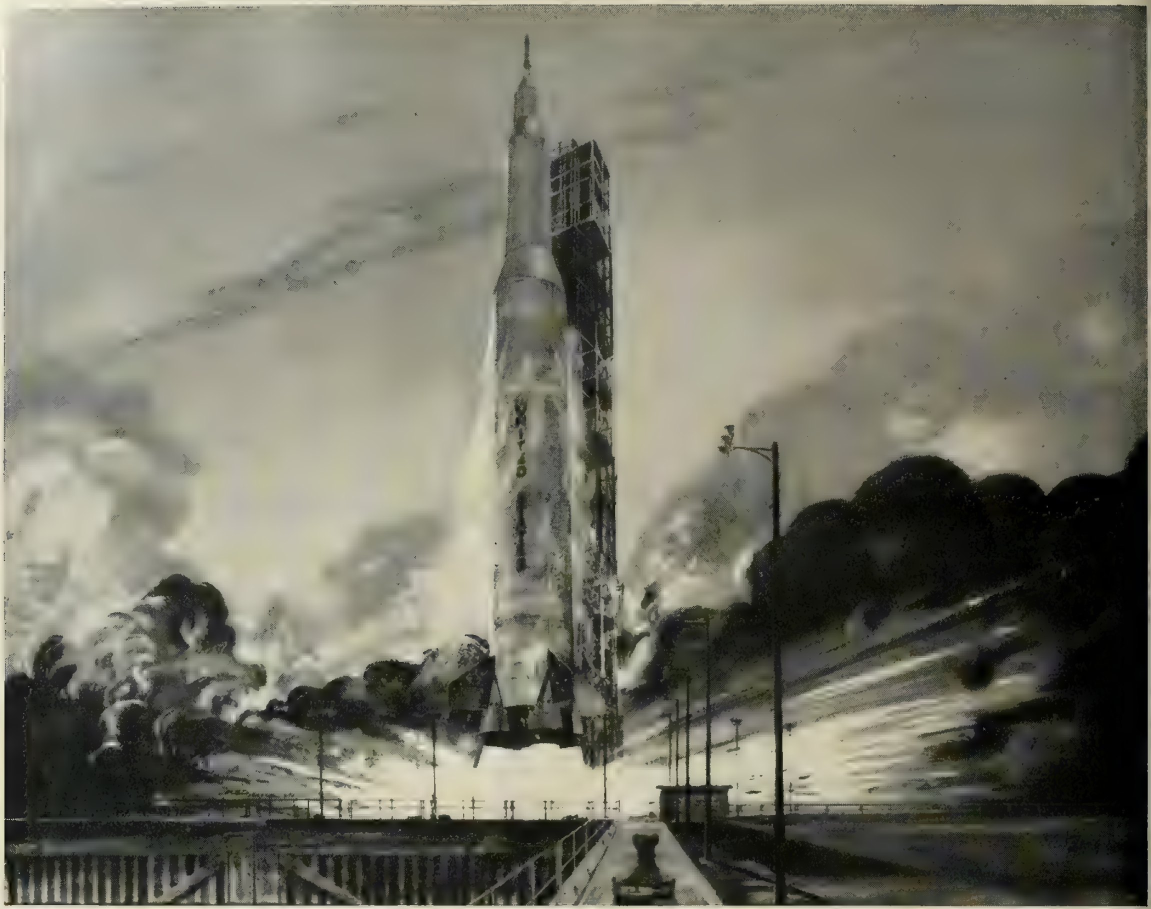
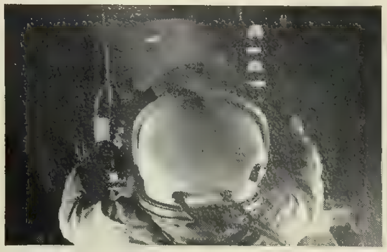


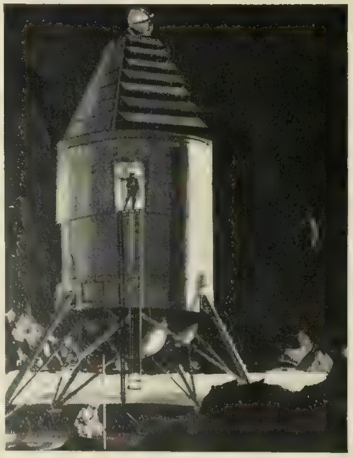
SATURN V, pictured in drawing above, will be the free world's largest rocket, standing tall as a 30-story building and measuring 33 feet in diameter. A National Aeronautics and Space Administration program, Saturn V will be used to launch men and equipment into earth orbit, lunar orbit, moon landings and deep space. Saturn will be able to place 100 tons in earth orbit, or transport several tons of instruments to Mars. Boeing holds NASA contract to develop, build and test the S-IC first-stage booster, comprising five F-1 engines developing a total thrust of 7.5-million pounds, equal to about 160-million horsepower.

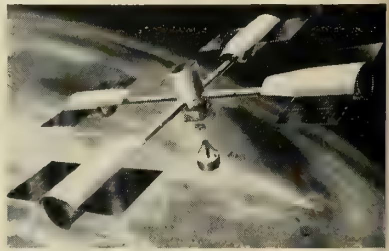
Capability has many faces at Boeing



SPACE RENDEZVOUS. Pilot sights orbiting vehicle and begins docking run for simulated rendezvous in space, one of many advanced Boeing research programs.

LUNAR LABORATORY and living quarters for four research men on moon, based on Boeing study. Laboratory contains command console and research instruments. Exploration from laboratory base would be by means of two-man moon-roving vehicle.





ORBITING LABORATORY. Designer's concept of manned orbiting space laboratory, based on Boeing studies. Also, under NASA study contracts and its own research programs, Boeing is studying ferry vehicles, lunar explorations and deep space probes.

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Personnel Woes Plague Headquarters

Budget cuts would reduce personnel strength below level sought for manned spacecraft program; Moon program would suffer

THE RECENTLY reorganized NASA headquarters is presently sweating over action by Congressional appropriation committees that could mean a sharp curtailment of its permanent personnel.

The House version of the agency's Fiscal '64 budget limits its personnel strength to 28,500. The Senate appropriations committee set no numerical ceiling, but it went along with the House funding approval of only $494 million, well below NASA's $560.3 million request for administrative expenses.

The problem is that NASA already has 29,965 people on board and had hoped—if the Moon program is to hold to its schedule—to have a total work force of 32,500 at the end of FY '64.

While the ceiling may be lifted during further Congressional action on the legislation, it has already forced an almost total halt to agency recruiting. If it is not overturned, the heaviest blow will fall on the Manned Spacecraft Center, where most of the new employees are needed.

In addition to its personnel problems, NASA headquarters is still working on final details of its reorganization.

The last step will probably be establishment of a Manned Space Flight Operations office at the Launch Operations Center to direct Project *Gemini* and *Apollo* launches. The director of the office will report to headquarters through Dr. Kurt Debus, director of LOC.

- **Chain of command altered**—The main change in the Nov. 1 reorganization of NASA headquarters calls for the field centers to report directly to one of three new associate administrators.

Previously the centers reported directly to the various project offices on matters concerning general operation, but on budget and fiscal matters, they reported to NASA's general manager, Dr. Robert C. Seamans, Jr.

DR. GEORGE E. MUELLER, left, was sworn in as Deputy Associate Administrator for Manned Space Flight by Deputy Administrator Dr. Hugh L. Dryden.

The space agency said the change would enable Dr. Seamans to concentrate on overall policy matters rather than direct management of the centers.

The other change combined the offices of space science and applications under one director, Homer E. Newell.

In addition to Newell, the other associate administrators who report to Seamans are Dr. George Mueller for manned space flight projects and Dr. Raymond Bisplinghoff for advanced research and technology programs.

The centers reporting directly to Dr. Mueller are Marshall Space Flight Center, Launch Operations Center and Manned Spacecraft Center. Reporting to Newell are Goddard Space Flight Center, Wallops Station, Pacific Launch Operations and Jet Propulsion Laboratory. Centers reporting to Dr. Bisplinghoff include Ames Research Center, Flight Research Center and Lewis Research Center.

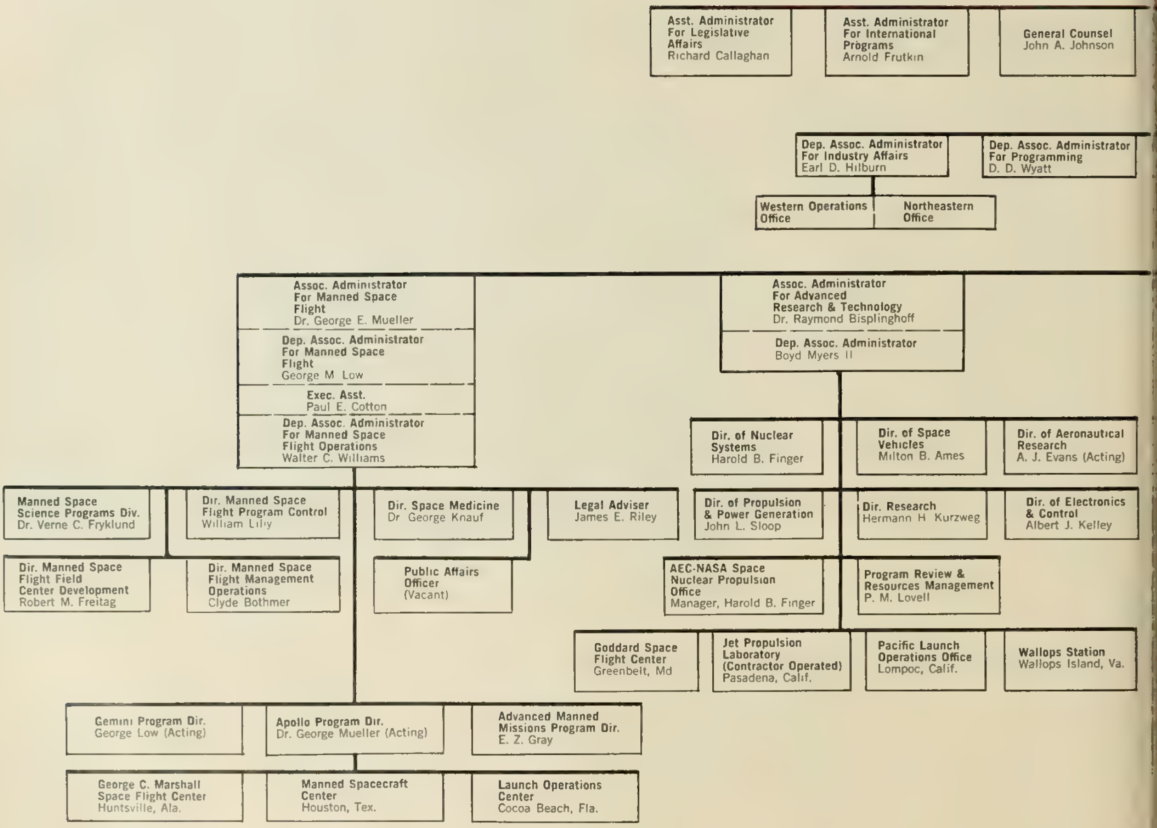
Within the program offices, most radical reorganization was made in manned space flight.

A new position of deputy associate administrator for flight operations was instituted and Walter C. Williams, formerly deputy director of MSC, was selected to fill the job. George L. Low was appointed to be Mueller's chief aid as deputy associate administrator for manned space flight.

Three new project offices were established—*Gemini, Apollo* and Advanced Manned Missions. Each of these three offices will have five divisions which will be duplicated in each NASA center. They are program control, system engineering, test operations, flight operations and reliability and quality.

Officials report that the aim of the manned spaceflight organizational structure is to avoid duplicating in Washington the work that is being done in each of the centers. (Turn page for latest organization chart.)

NASA HEADQUARTER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Jet Propulsion Laboratory (Contractor Operated) Pasadena, Calif.
Pacific Launch Operations Office Lompoc, Calif.
Wallops Station Wallops Island, Va.
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Apollo Program Dir. Dr. George Mueller (Acting)
Advanced Manned Missions Program Dir. E. Z. Gray
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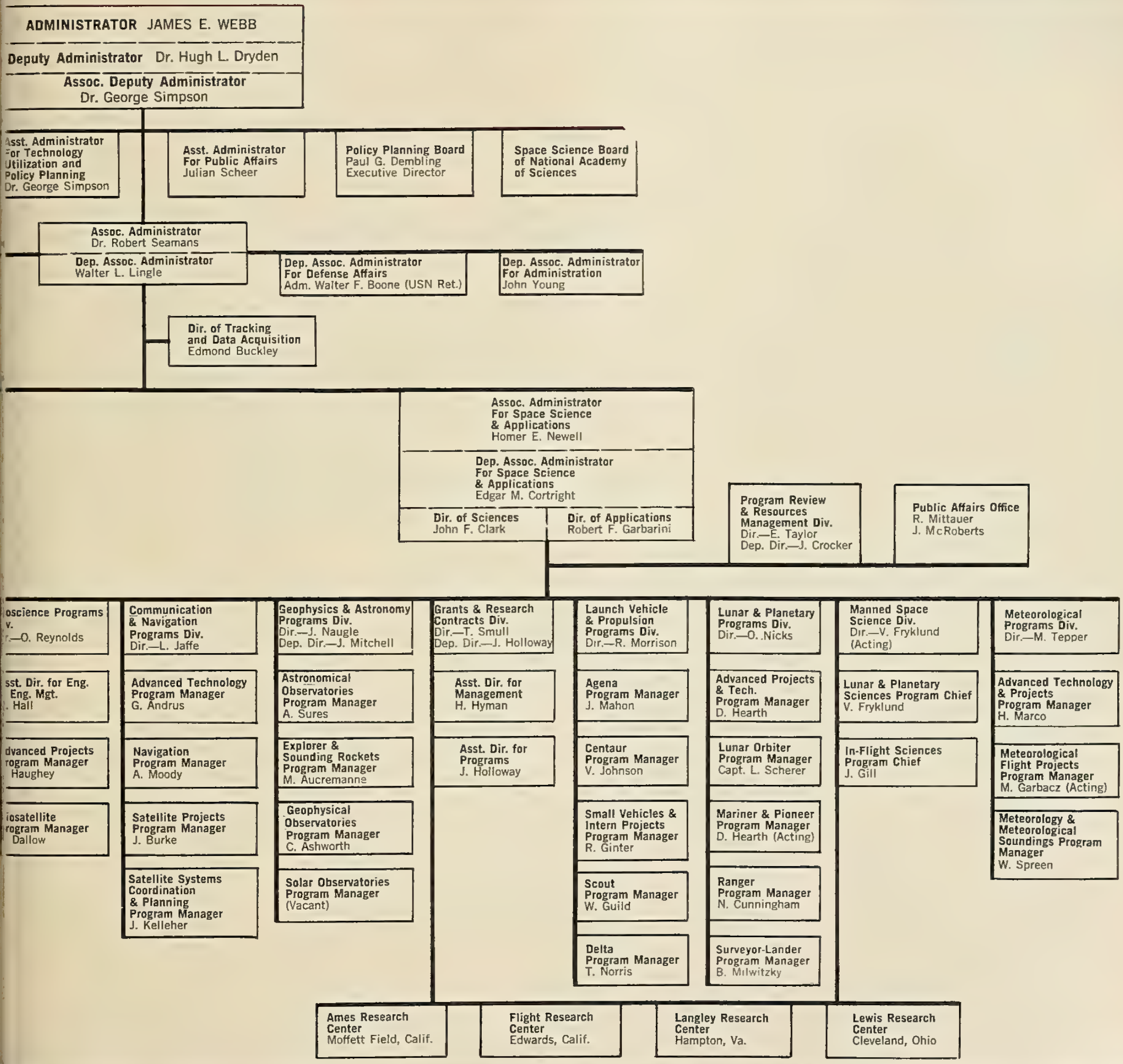
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Meteorological Flight Projects Program Manager M. Garbacz (Acting)
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Proposed Research Center Seen as Tonic for Electronics Effort

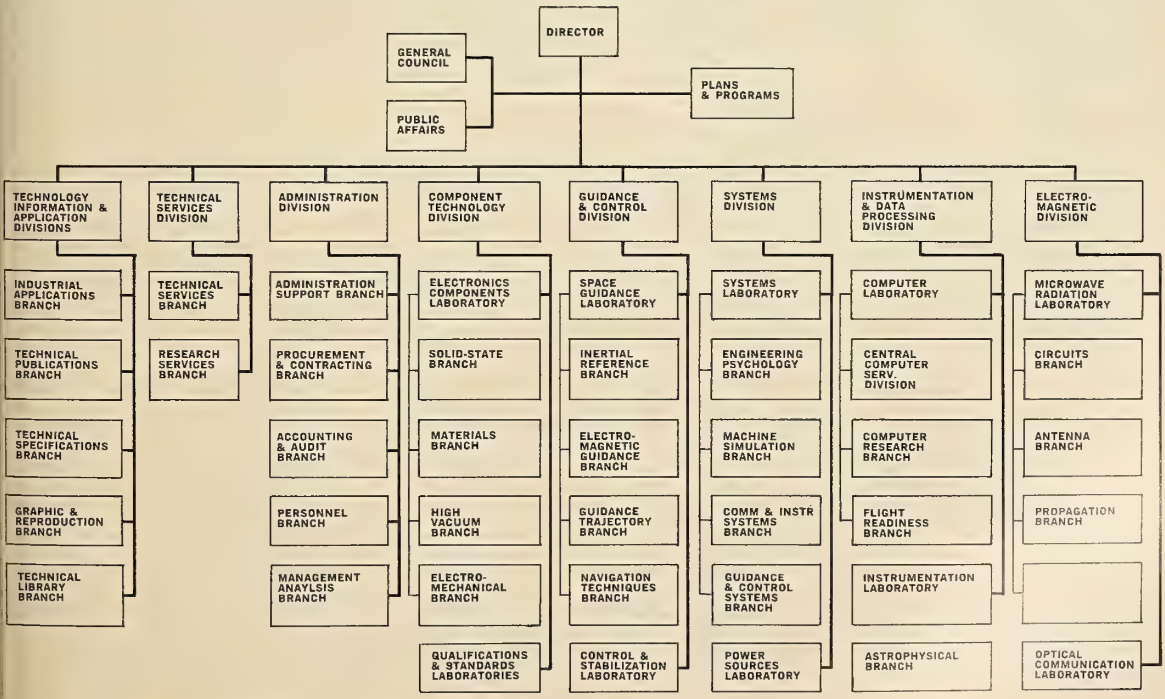
To serve as 'repository' for research; to support MSFC, MSC, GSFC and JPL; industry and universities to get 70-80% of programs in form of research grants from NASA

TEN MAJOR LABORATORIES, many of them to be developed in modular increments during the next four fiscal years, will form the heart of a proposed Electronics Research Center.

NASA says the labs will allow development of electronics compatible with successful advanced space missions and strengthen what the space agency has termed "a significant weakness within the agency."

As NASA sees it, ERC would serve "as the repository of space agency electronics research competence."

ERC, for the most part, will support Marshall Space Flight Center, Manned Spacecraft Center, Goddard Space Flight Center and Jet Propulsion Laboratory, much in the same manner as Lewis, Ames, Langley and Flight Research Centers support these same centers in other technological areas.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OPTICAL COMMUNICATION LABORATORY

In effect, the ERC will supervise the entire NASA electronics effort, though without necessarily moving to the ERC centers of competence that have grown up at other installations.

Of the total program envisioned for ERC, planners estimate between 70 to 80% will be in the form of industry contracts or university grants.

About 60% of the total technical effort will involve component, technique and sub-system applied research in electronics. Most of this will be out-of-house; however, planners stress that NASA will attempt to retain enough in-house so that its competence to properly orient, define and evaluate work done out-of-house is maintained and increased.

About 15 to 25% of the total effort will be directed toward combining advanced techniques and components into advanced systems. These, in fact, will not be flight-ready systems but will be used to check feasibility as a system and study optimum configurations.

ERC will devote 10 to 20% of total effort to basic electronics research, an area which NASA feels "has a higher risk than applied research," but an area historically proven as one which often yields the "breakthrough."

The proposed organization of ERC, growth of the professional staff, and installation plan are illustrated in the accompanying charts.

Ten major laboratories, plus an engineering and administration building, will make up the complex. If Boston is confirmed as the site, the physical layout of the complex will then depend upon whether or not the space agency chooses to build upon air rights granted over the Massachusetts Turnpike or uses a proposed 1,000 acre site in the greater Boston area.

GROWTH OF ERC PROFESSIONAL STAFF

	FISCAL YEARS				
	1964	1965	1966	1967	1968
Electronic Components Lab.	12	35	50	75	100
Power Conditioning and Distribution Lab.	12	20	35	45	55
Qualifications and Standards Lab.	12	25	45	65	85
Instrument Research Lab.	8	25	30	45	55
Microwave Radiation Lab.	8	25	35	45	55
Space Guidance Lab.	12	30	50	55	70
Optical Communications Lab.	12	25	35	45	65
Computer Research Lab.	8	20	35	45	60
Control & Information Systems Lab.	8	30	45	65	80
Systems Lab.	8	15	40	65	75
TOTAL	100	250	400	550	700

The labs and their current areas of interest include:

—Microwave Radiation Lab—To be built and equipped in increments over a three-year FY'66-68 period, this lab will conduct research on tracking, voice and telemetry communications, power generation and amplifiers. Facility will have shielded rooms, anechoic chambers and antenna ranges.

—Space Guidance Lab—Will be constructed so that another module could be added in FY'67. New inertial reference frame measurement techniques, electrostatic and cryogenic suspension applications, stellar navigation, guidance computers and trajectory mechanics will be investigated there.

—Electronic Components Lab—Also capable of being expanded in FY'67. Intensive R&D on electro-physics and related phenomena. Included is research on gas and solid phenomena, active and passive circuit development, new miniaturization and radiation-resistant circuit techniques.

—Optical Communications Lab—Also proposed for modular addition in FY'67. This group will study physical phenomena associated with the visible and near-visible spectral region, including infrared and ultraviolet. Also, laser light generation and power devices, modulation and demodulation methods, propogation, antenna systems, and feasibility demonstration and component development.

—Instrument Research Lab—Constructed in two modules, research would be aimed at reduction of physical phenomena to electronic analogues, transducer technology including digital transducer development, simplified and automatic checkout equipment, and biomedical instrumentation.

—Computer Research Lab—Will research new methods for data handling, computation, and processing. High-speed computation, large and fast access memories, adaptive devices, a certain amount of radiation-resistant computer component development, checkout and launch computers, and advanced concepts on pneumatic fluid-type computers will be pursued.

—Control and Information Systems Lab—Very broad range including: advanced control methods; assimilation, correlation and reduction of control data; recognition devices; displays and new sensors; more effective operator controls, servos, and actuators.

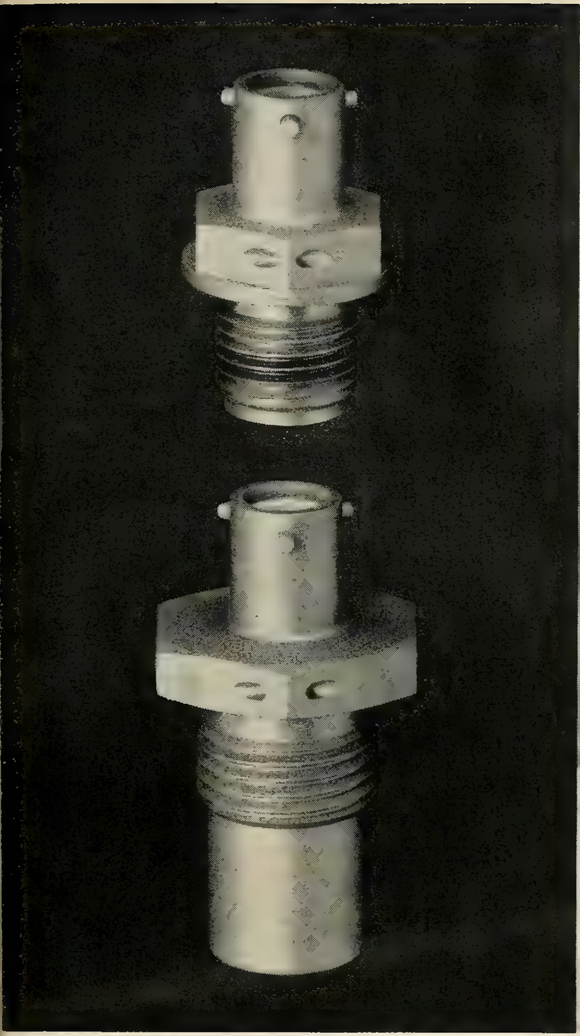
NASA ELECTRONICS RESEARCH CENTER INSTALLATION PLAN *(Dollars in Millions)*

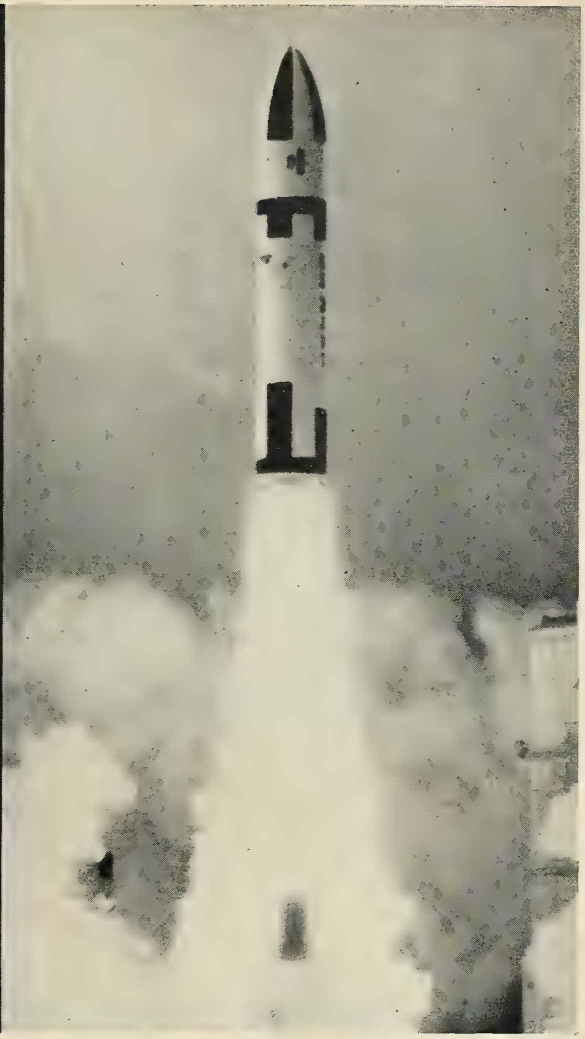
FACILITY (functional titles)	TOTAL COST	FISCAL YEARS			
		1965	1966	1967	1968
Microwave Rad Lab	(7.0)	—	5.0	1.0	1.0
Space Guidance Lab	(5.5)	4.5	—	1.0	—
Electronic Components Lab	(6 0)	4.0	—	2.0	—
Optical Communications Lab	(4.5)	2.5	—	2.0	—
Instrument Research Lab	(6.0)	—	4.0	—	2.0
Computer Research Lab	(4.0)	—	2.5	1.5	—
Control & Information Systems Lab	(3.5)	—	3.5	—	—
Power Conditioning and Distribution Lab	(5 0)	2.5	—	—	2.5
Qualification & Stds Lab	(8.0)	3.0	2.0	2 0	1.0
Systems Lab	(4.5)	—	2.5	—	2.0
Eng. & Admin. Bldg.	(2.0)	2.0	—	—	—
Yearly Increment		18.5	19.5	9.5	8.5
CUMULATIVE TOTALS		18.5	38.0	47.5	56.0

—Power Conditioning and Distribution Lab—Effort here will concentrate on regulation and distribution of power to drive mechanisms for antennas, S&C devices, circuits and wire networks. Development will include new regulators, inverters, and converters based on analyses of future requirements and state-of-the-art status. By-products of this research ought to cut down on interference between systems and lead to standardization of voltages and reliability of power conditioning devices.

—Qualifications and Standards Lab—One of the most important, according to NASA, in that it will help in development of a group of standardized and qualified space components that are seen as the real key to improved reliability. Initial module will be constructed to allow addition of new modules and equipment in FY's '66, '67, and '68 The lab will seek to establish electronic design and fabrication standards, component qualification testing schemes and prepare the long-sought-after spec for space-qualified sub-assemblies and sub-systems. The lab will also do considerable reliability analysis. Lab will have major effect on the other Center and on the entire electronics industry

—Systems Lab—Designed basically to aid in the liaison between technology component and sub-system research and prototype systems development; also will help solve systems developmen problems of the NASA centers. ∎





EBW squibs and detonators come of age as Eimac flies with Polaris A-3

With built in protection against accidentally applied DC or RF voltages, new Eimac exploding bridge wire squibs and detonators represent a significant advance in the state-of-the-art. Structural integrity is assured: pin-to-ceramic and ceramic-to-body bonds are *brazes* of vacuum tube quality, proved reliable in more than ten years' manufacturing history. These Eimac EBW devices are now being flown on the new Polaris A-3, developed by Lockheed Missile and Space Company, Sunnyvale, California, for the U.S. Navy.

Eitel-McCullough, Inc., manufacturers for 29 years of Eimac electron power tubes, now brings to the aerospace and ordnance industry a vast technological experience in the behavior of exotic materials at high temperatures, under vacuum, and at extremes of pressure, vibration and shock.

Eimac possesses unmatched facilities to develop ceramic and ceramic-metal structures for new needs of aerospace and ordnance: Eimac was the first and has remained the largest manufacturer of ceramic-metal electron power tubes. Recent advances at Eimac have made it possible to design new electro-mechanical structures which will operate reliably in a wide variety of corrosive environments.

Eimac's new squibs and detonators for Polaris A-3 were developed and placed into production in less than four months. For similar quick reaction to solve similar structural problems, get in touch with our Accessory Products Division Marketing.

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- R-F HAZARD
- ELECTRICAL RESISTANCE
- INSULATION RESISTANCE
- NO FIRE

ENVIRONMENTAL
- TEMPERATURE-HUMIDITY
- LEAKAGE IMMERSION per MIL-E-5272
- TRANSPORTATION-VIBRATION per MIL-STD-353
- VIBRATION per Gaussian random variation
- SHOCK – 200 G's
- ACCELERATION – 13 G's
- TEMPERATURE-ALTITUDE 175°F., 500,000 ft.

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- COMPATIBILITY
- TIME VS. CURRENT
- BRUCETON ANALYSIS – Nav Ord 2101

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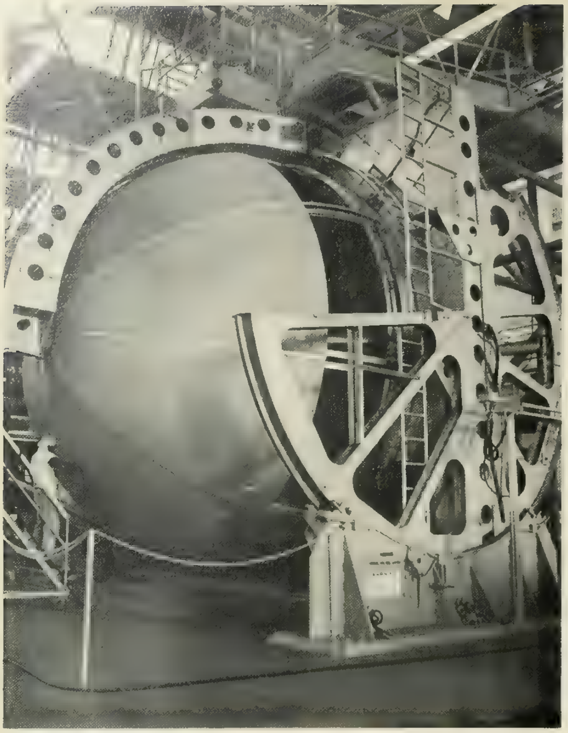

HUGE BULKHEAD of S-IVB Saturn stage in welder fixture at Douglas Aircraft, S-IVB prime to Marshall Center.

TOP: actuator for Saturn V controls at Moog Servocontrols. BOTTOM: Drawing of MSFC Test Laboratory complex.

NASA/installations

Marshall Budget Near $2 Billion

Industry to share in 92%; construction needs drop off; center settling down to testing, R&D; FY '65 Saturn V 'plateau year'

HUNTSVILLE, ALA.—Marshall Space Flight Center will reach mid-decade with a budget close to $2 billion showing a further shift in emphasis from the current construction boom to the bread-and-butter business of testing, development and research.

Of a rough $2-billion figure, industry could expect to share in 92%.

In the manned space flight program, *Saturn V*, the biggest noise at Marshall, will show an estimated increase in the level of effort of 20% in the coming fiscal year. The FY '64 budget was $676.5.

One official described FY '65 as a "plateau year" for *Saturn V*.

Saturn I-B's level is expected to rise about 25%.

A sharp decline of about 50% is forecast, however, for *Saturn I*, which will be superseded by the *S-IB* effort. *Saturn I* development is slated for $160 million in the FY 1964 budget.

Construction is expected to continue a steady decline as gaps in facilities are rapidly filled in. The drop from this fiscal year to next will be from $166 million to $140 million.

Construction at Marshall itself will be between $25 and $30 million in 1965.

Officials said that the only major new construction item they would press for in the coming fiscal year would be a research laboratory to support work in the Research and Development division.

Construction forecasts for the booster assembly plant at Michoud, La., indicate below $10 million for the coming year.

At the Mississippi Test facility, the funding level will drop to between $8 and $90 million.

• **Money uncertainties**—In discussing forecasts, however, NASA official were reluctant to go into much detai on fund allocation even on the 196 budget, let alone 1965, because of th unseemly tardiness of Congress in getting out the 1964 appropriations bil

Meanwhile, Marshall has shake down in a new organization plan whic went into effect last month, designe to streamline the chain of direction under Dr. Wernher von Braun.

The reorganization set up two majo groups, Research and Development Operations, under Hermann K. Weidne and Industrial Operations, with Robe B. Young in charge. Young came t duty officially Nov. 1 from Aeroje General Corp., where he was a vic president and general manager of the Sacramento plant. Weidner was formerly deputy director of the propulsion and vehicle engineering division.

Weidner's deputy is Jerry C. McCall, while Young's is Hans Heuter.

The eight former R&D divisions at Marshall have been redesignated laboratories. These are Aero-Astrodynamics, Astrionics, Computation, Manufacturing & Engineering, Research Projects, Propulsion & Vehicle Engineering, Quality Assurance & Reliability, and Test. The ninth unit in R&D, Launch Vehicle Operations, is at Cape Canaveral.

The three major project offices, *Saturn IB, Saturn V,* and Engine Projects, are under Industrial Operations, together with Michoud and Mississippi Test operations.

Upstairs at Marshall, Eberhard F. M. Rees is the technical deputy director, and Harry H. Gorman is administrative deputy director. Oswald H. Lange is assistant director for scientific and technical analysis.

In Industrial Operations, Arthur Rudolph has returned from Redstone Arsenal to head the *Saturn V* project office, while Col. Lee B. James, former assistant to Rees, is directing the *Saturn I-B* project.

Marshall's total Civil Service strength as of Oct. 1 was 7,328, of which 4,975 were in R&D and 741 in Industrial Operations. Officials expected the total figure to move past 8,000 next year.

The force at Michoud Operations was 8,062, according to most recent official count. The Boeing Co. accounted for 3,888 of this, while Chrysler had 3,116 persons at Michoud. Officials there expect significant additions to the quality control staff to bring strength up to about 8,500 in FY 1964.

Looking at the general outlook, Gorman, the deputy for administration, said he did not think that the budget "will go up much, but there will be a shift in the mix of dollars. Construction will be down, and R&D up."

He said that there are "no plans for major test facilities in addition to what we have." Any further requirements will be in scattered support areas.

● **Beyond Saturn?**—The major question beginning to preoccupy Marshall and Headquarters planners is what course matters ought to take after Saturn. *Nova* is the stock concept for a follow-on, but *Nova* is currently a state of mind.

There will have to be larger but flexible test facilities, according to Gorman. However, he pointed out that "to say that none of the present facilities would be adapatable to *Nova* would be entirely incorrect."

Study of a "Class III" *Nova* vehicle using a new high-pressure liquid hydrogen engine, or engines may be awarded

MARSHALL FISCAL 1964 BUDGET

RESEARCH, DEVELOPMENT AND OPERATIONS

Personal Services & Benefits	$ 80,940,000
Institutional Support (Includes $4,300,000 Travel Limitation)	47,060,000
Direct Research & Development Program	1,359,862,000
Construction of Facilities	166,017,000
GRAND TOTAL	$1,653,879,000

PROGRAM SUMMARY

	TOTAL FY64
MANNED SPACE FLIGHT	$1,309,450
Launch Vehicle Supporting Technology	13,200.
Propulsion Supporting Technology	7,250.
Saturn I Vehicle Procurement	117,100.
Saturn IB Vehicle Procurement	3,000.
Saturn I	159,900.
Saturn IB	146,600.
Saturn V	676,500.
H–1 Engine Development	8,600.
RL–10 (A–3) Engine Development	25,000.
F–1 Engine Development	62,300.
J–2 Engine Development	56,600.
Advanced Studies	13,400.
Multi-Purpose Cryogenic Space Statge	20,000.
CONSTRUCTION OF FACILITIES	$166,017
Huntsville	28,980.
Michoud Plant	8,688.
Mississippi Test Operations	100,196.
Various Locations	28,153.

FACILITIES

	TOTAL FY64
MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE	$28,980
GENERAL	**6,535.**
Project Engineer Office	2,650.
Utility Installations	3,885.
SATURN V	**22,445.**
Acceleration Test & Calibration Facility	1,650.
Accoustic Model Test Facility	1,900.
Additions to Components Test Facility	3,675.
Addition to the Test Support Shop	1,500.
Barge Dock & Loading Facilities	591.
Expansion & Modernization of the High Pressure Gas & Propellant System	2,000.
Extension to the Load Test Annex	3,656.
Hangar for Vehicle Components	3,500.
Hazardous Operations Laboratory	473.
Modernization of Instrumentation & Control System in East Area	3,500.
MICHOUD PLANT	$8,688
SATURN V	**8,688.**
Additions to Production Facilities	5,220.
Parking and Security Improvements	460.
Road & Airstrip Rehabilitation	375.
Vehicle Component Supply Building	2,633.
MISSISSIPPI TEST	$100,196
MISSISSIPPI SATURN (ENGINE)	**6,541.**
F–1 Engine System Test Stand	6,541.
SATURN V	93,655.
Advanced Saturn First Stage (S–1C) Static Test Facility	35,983.
Advanced Saturn Second Stage (S–II) Static Test Facility	19,148.
Bridge for U. S. Interstate Highway No. 10	4,500.
Control Center and Data Acquisition & Handling Facilities	4,613.
Electronic Instrument & Materials Lab	2,716.
Maintenance Facilities	2,280.
Navigation Lock	6,604.
Sonic Measuring Facilities	1,760.
Transportation & Parking Facilities	4,597.
Utility Additions & Extension	6,559.
Warehouse Addition & Storage Facility	936.
Waterways & Docking Facility	3,959.
VARIOUS LOCATIONS	$28,153.
MSFC—Propulsion Facilities	
FACILITIES FOR F–1 ENGINE PROGRAM	$14,238.
Edwards Air Force Base	2,775.
Canoga Park	9,240.
Santa Susana	2,223.
FACILITIES FOR H–1 ENGINE PROGRAM NEOSHO	$1,410.
FACILITIES FOR J–2 ENGINE PROGRAM	$6,900.
Santa Susana	1,060.
Canoga Park	5,840.
RL 10 A–3 ENGINE TEST FACILITY	$500.
West Palm Beach	
FACILITIES FOR THE S–IVB STAGE PROGRAM	$5,105.
Santa Monica	

n about a year, according to officials. They hope to award a program definition contract for a *Nova* launch vehicle in "two or three years." But at the moment almost anything to do with *Nova* remains in the order of educated speculation.

One hope for the future is possible assignment to Marshall of a lunar base project, which is on the list of the Future Projects Office. Such a development conceivably could lead to requirements for new space chambers and laboratories at the center and a new spurt of construction.

In the meantime, Marshall officials are still trying to justify NASA headquarters a $20-million request in Fiscal 1964 for a multipurpose mission module. This would be the third stage of the *Saturn I-B* booster.

Headquarters, however, maintains that the flat upper stage with two *Centaur* engines should not take precedence over other future projects such as a manned space station or lunar logistics vehicle.

Current budget at Marshall totals $1.654 billion, of which $1.360 billion is for direct research and development.

In engine development, the F-1 is allocated $62 million, followed by J-2 with $57 million and RL-10 with $25 million. Officials said there are no plans to test the M-1 liquid hydrogen engine at Marshall. This will probably be done at Mississippi Test, Aerojet-General, or at Lewis Research Center.

Advanced studies requests were $13.4 million.

Of the $166-million 1964 construction figure, MSFC-Huntsville accounted for $28.9 million, Mississippi Test Operations $100 million, and various other locations, $28 million.

Scheduled for completion late next year are the massive *Saturn V* static test stand, known as the "Alabama pyramids," and the F-1 test stand.

Bid advertisements for Huntsville facilities going out in the next five months include among major items:

Additions to components test facility, $3.67 million; extension to the load test annex, $3.65 million; hangar for vehicle components, $3.5 million; acceleration test and calibration facility, $1.65 million; acoustic model test facility, $1.9 million; and modernization of the instrumentation and control system in the east area is scheduled to get $3.5 million.

- **Michoud operations**—Fabrication of the S-I, S-IB and S-IC stages of *Saturn* will begin at Michoud before the end of the year.

Chrysler already is putting together four S-I stages, including SA-111 and SA-112, the first two definitely earmarked for manned flight. SA-8 and SA-10, R&D vehicles, are being clustered.

Fabrication of spider beam assemblies for SA-111 and SA-112 has been started, and clustering of SA-111 will start by the end of September.

The Michoud plant was ordered converted to *Saturn* fabrication and assembly operation in September, 1961, and Mason-Rust was hired to provide support services.

Chrysler moved in on Jan. 20, 1962, and received its first major contract Aug. 1, 1962.

One of Chrysler's first moves was to establish a classroom where locally hired personnel were trained in several

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skills, including sheet metal working, welding and soldering.

- **Flow pattern**—The Chrysler portion of the plant was set up in a manner to assure the even flow of materials and components from receiving dock to final assembly.

All items destined for the Chrysler-built *Saturn* are received and classified, then are thoroughly inspected before going into storage. Samples of materials such as steel, rubber and plastics are run through a materials laboratory to assure that each lot meets specifications.

Larger components such as tanks and engines are received "bare" and are prepared for assembly in the shops. Rocketdyne engines are inspected on receipt, then cabling and tubing are installed before the engine is checked out under operating pressures.

The bare tanks produced by Ling-Temco-Vought are "stuffed" by added cabling, tubing and pressure spheres before being subjected to pressure tests.

Clustering operations start with erection of the tail section, then the 105-inch center tank is added. As soon as the second-stage adapter is in place, the eight 70-in. tanks are added. The stage is completed when the eight engines are in place.

Before shipment to Huntsville for static firing, the stage will be put through a simulated flight in the factory.

After the stage is returned from Huntsville, Chrysler technicians will remove gauges and measuring devices used in the static firing. Then they will add the flight harness, clean the vehicle, paint it, determine the center of gravity, weigh it and prepare for shipment to the Cape.

- **Shipping dates**—The SA-8, first of the S-I stages built by Chrysler, is due to be shipped to Huntsville before the end of the year. The first S-IB is due for delivery to Cape Canaveral in May, 1965.

Boeing will begin assembly of its first S-IC stage in the fourth quarter of this year and start vertical assembly a year later. The stage, designated S-IC-F, is to be delivered to Merritt Island in the summer of 1965 for use in checking out facilities at *Saturn V* Complex 39.

- **Boeing role**—Most of the Boeing fabrication will take place in the company's Wichita plant but some will be done in Seattle. The Michoud operation will be devoted almost entirely to assembly.

One of the principal exceptions to this is milling of the "Y" ring, used in forming bulkhead domes. The 33-ft. ring comes to the plant in three segments that are welded together, then cut on a huge boring mill.

The Boeing portion of the Michoud operation is now going through the activation phase, with most of the emphasis being placed on tooling up for the big job.

Many of the people involved, both engineering and management, have had wide experience in missile and airplane construction. They participated in the *Bomarc* and *Minuteman* missile programs and have worked on Boeing planes.

Some Boeing personnel at Marshall are designing an automated checkout for the S-IC stage, which is a NASA requirement. The work is being done at Huntsville. ■

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Manned Spacecraft Center Needs $25 Million More in FY '65

HOUSTON—The Manned Spacecraft Center will need about $25 million for new facilities in Fiscal 1965. A large space station project, however, could push total cost of center installations to $250 million.

The center also expects to build a Space Physics Laboratory, but no target date has been set for its initiation.

The $25-million Fiscal '65 request includes facilities for the space environment section, a building and equipment to check the interface between flight hardware and ground systems, and $8 million for expansion of the space chamber facilities.

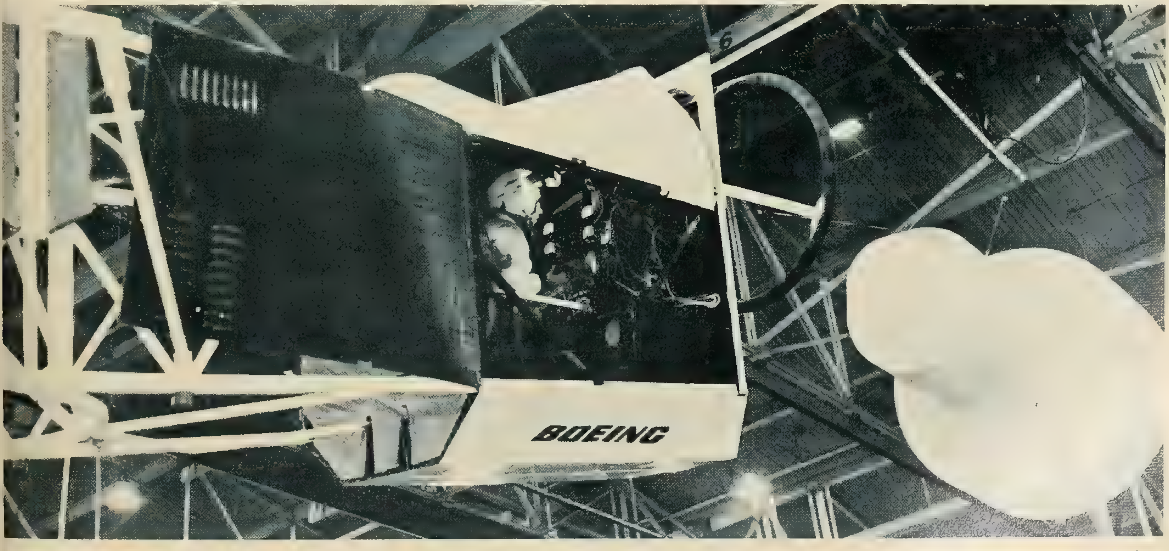
Most of the space chamber money will increase the solar radiation capability so that more spacecraft area can be exposed to the Sun simulator's rays. Since it appears that the LEM and other *Apollo* modules will occupy the vacuum chambers simultaneously, more room will be needed to prepare the spacecraft for testing, center officials said.

Although there will be new facility money next year, MSC will need more human skills than new technical facilities over the next few years.

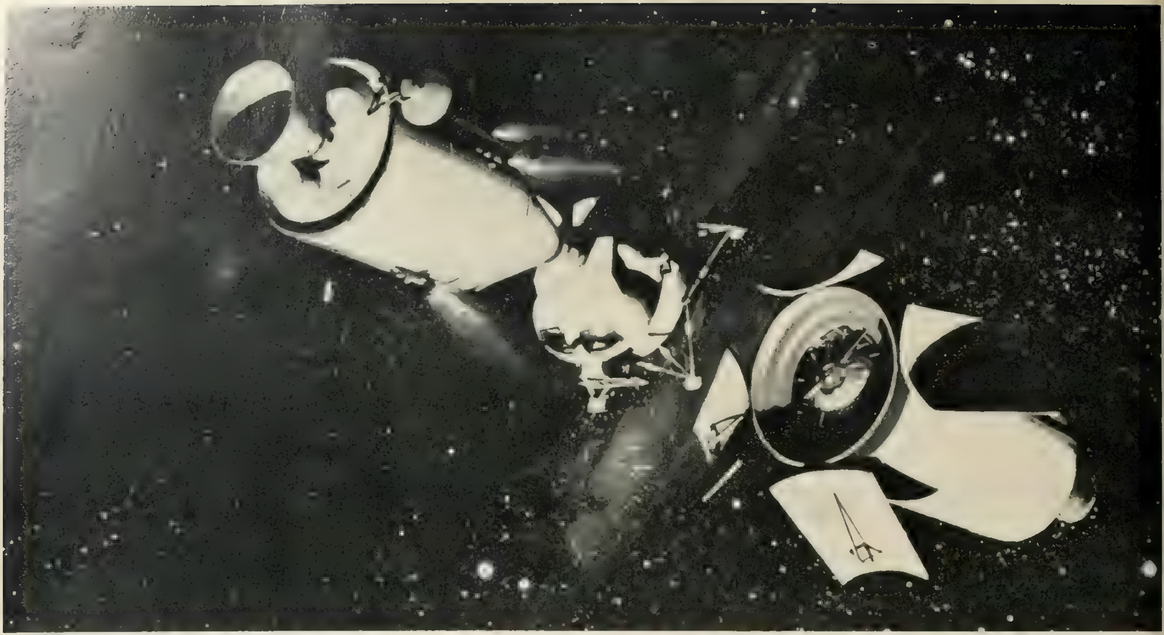
Center leaders believe that the $153 million now authorized by Congress through Fiscal '64 will support the test and development of most manned spacecraft now contemplated. Most of the 3,500 men and women of MSC will occupy the new Clear Lake center during March and April. Major elements, however, will remain at Ellington AFB until July and perhaps later. This includes the 30-man astronaut corps.

Dr. Robert R. Gilruth, center director, said the center was designed two years ago to provide a margin for additional projects without major modification or construction. Additions and expansions will adapt present facilities to most needs beyond *Gemini* and *Apollo*.

Only a new program the size of the



BOEING PILOT simulates orbital rendezvous with "space ship." Pilot brings the vehicle into position for docking with mockup carried by crane. He controls "space ship" through analog computer to indicator which directs crane operator.



ARTIST'S CONCEPTION shows Grumman's two-man Lunar Excursion Module and North American's Apollo Command and Service Modules separating from Douglas S-IVB stage of Saturn booster in manned launch.

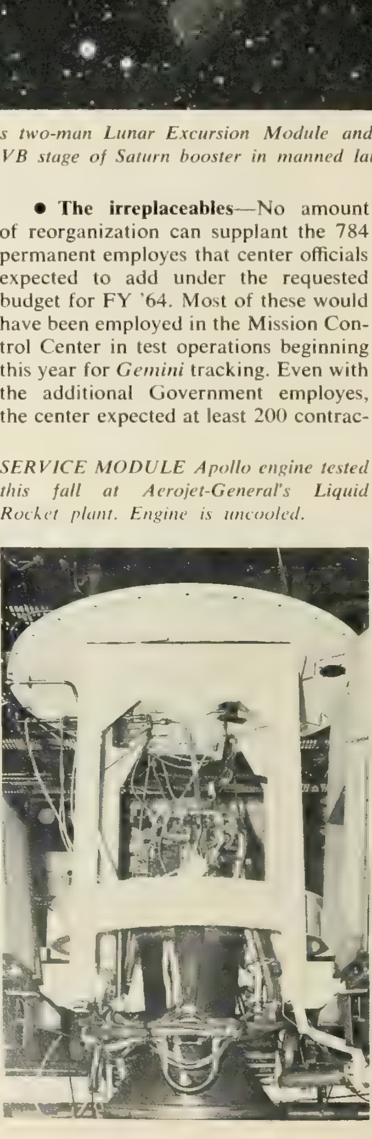
largest manned orbiting space station, for instance, would call for a particularly large investment in new facilities. A program of this scope could boost center facilities toward the $250-million mark, said Dr. Gilruth, Deputy Director James C. Elms, and Maxime Faget, associate director for engineering and development.

• **Manpower crucial**—Manpower more than facilities becomes the critical factor now and later, interviews with these directors and other center leaders revealed. Aerospace contractors in almost all areas will find an increasing demand for service contracts. Even before Congress clamped a ceiling on NASA manpower, the Manned Spacecraft Center employed more than 500 persons indirectly. They worked for contractors, such as Lockheed in electronics, to provide technical services in areas where MSC lacked manpower. This figure includes also such contractors as those for security, maintenance, and custodial services.

Deputy Director Elms, who assumed general center management when Walter C. Williams became Deputy Associate Administrator for Manned Space Flight Operations, has completed the reorganization program aimed at more efficient use of personnel "slots" assigned to MSC. Elms said the new organization would "obtain maximum direct input from Engineering, Mission Control, and the Astronaut Flight Crews into the *Gemini* and *Apollo* programs and deploy the full strength of the *Mercury* team into these projects."

• **The irreplaceables**—No amount of reorganization can supplant the 784 permanent employes that center officials expected to add under the requested budget for FY '64. Most of these would have been employed in the Mission Control Center in test operations beginning this year for *Gemini* tracking. Even with the additional Government employes, the center expected at least 200 contractor personnel to assist in the computer and control data operation at the center.

SERVICE MODULE Apollo engine tested this fall at Aerojet-General's Liquid Rocket plant. Engine is uncooled.



Cancellation of the four *Saturn I-Apollo* manned shots scheduled to begin in 1965 has postponted until late in 1966 a full-scale *Apollo* flight control problem. Except for unmanned flights using full ground control, the network connected to the control center will not handle a three-man *Apollo* flight until the first of eight *Saturn IB-Apollo* flights begin late in 1966. The eight manned shots will be preceded by four unmanned developmental flights carrying the full assembly of Command Module, Service Module, and Lunar Excursion Module.

• **Gemini training**—For project *Gemini*, the astronaut flight crews will begin training in April with completion of a temporary docking facility.

The temporary rendezvous and docking simulator at MSC was one of three facilities reprogrammed into operation after all FY '64 budget requests hit a log-jam in Congress. Center officials used $299,000 to erect three temporary steel-framed buildings to house the translation and docking facility; an arc jet wind tunnel to simulate re-entry heating on large structural sections, an item in the FY '64 budget; and a radiological laboratory to test spacecraft shielding techniques. Ironically, these temporary facilities were the first in operation at the new center and a long life seems in store for them.

The first crew for Project *Gemini* should be selected around August of 1964, center officials said. No one-man

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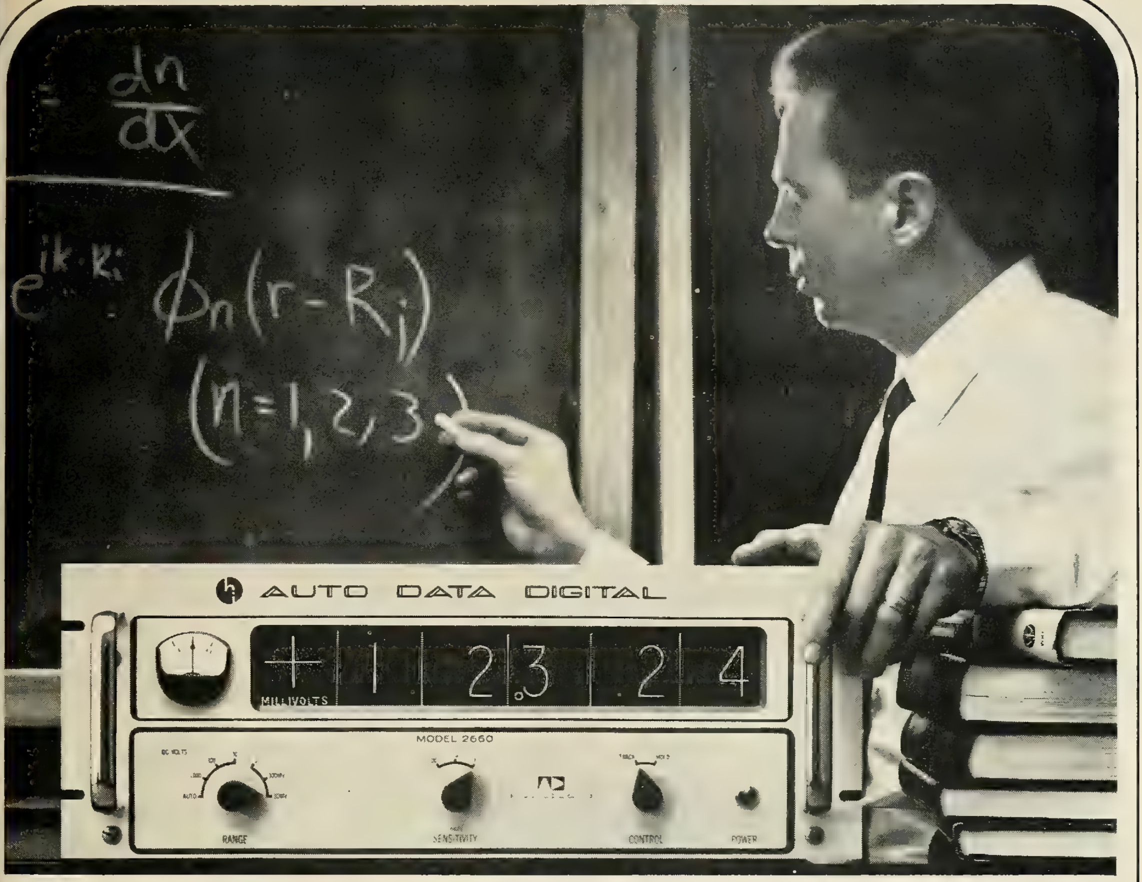

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Gemini flights are contemplated. Crew selection should come soon after the suborbital flight planned at mid-1964 with a "mechanical man" sequencing all controls from lift-off to re-entry.

- **First Gemini flight**—As things stand now, the first manned *Gemini* flight is scheduled for December of 1964. The first crew's sole mission will be to qualify the spacecraft.

On the second flight, however, astronauts will attempt to leave the spacecraft for the first time wearing space suits. Planned sequence for this excursion calls for the astronouts to de-pressurize the spacecraft while both men are in the craft connected to the *Gemini's* life support system. The men also will have bottles of extra-vehicular oxygen attached to their space suit connections.

After spacecraft pressure equalizes with the space environment's vacuum, *Gemini* officials said, one of the astronauts will open his hatch.

If the reactions of the spacecraft and the astronauts remain normal, the astronaut will then stand up in his seat and gaze out into space, for the first time facing the environment with the minimum protection a human can have and survive. The next step will be to climb out of the spacecraft and float out into space. His only attachment to the ship will be a tether line or telescoping pole.

This same maneuver series has also been scheduled for the fourth *Gemini* flight in case the sequence cannot be completed during the second flight. Flights two and four are programmed for long duration.

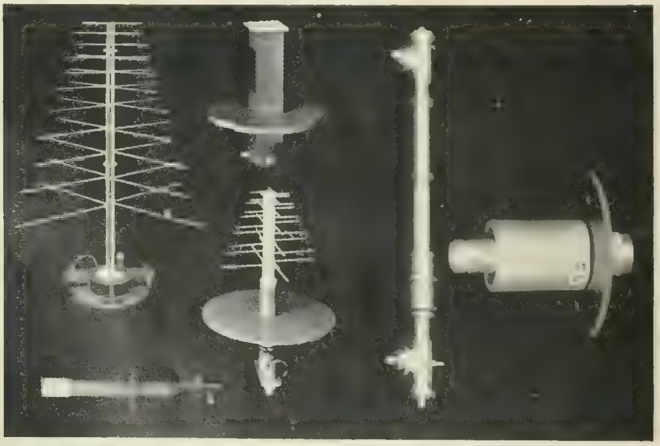
Gemini Flight Three will be the first rendezvous attempt. The rendezvous target will be a pod carried piggy-back in the *Gemini* adapter section. *Agena* rendezvous attempts should begin in mid-1965 when the MSC Mission Control Center becomes fully operational. Classification has been lifted from the estimated termination date of the $456,650,062 agreement with McDonnell Aircraft Co. for *Gemini;* the completion date is April 30, 1967, after 12 manned *Gemini* spacecraft have flown.

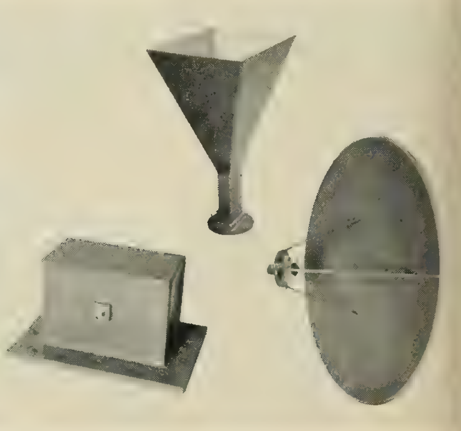
- **Decision on paraglider due**—At North American Aviation, the *Gemini* paraglider is heading toward a showdown. The gremlin-troubled inflatable wing has until the middle of June to prove itself, said Charles W. Mathews, acting project manager.

North American on Oct. 1 received a new contract of $20,015,000 for further paraglider research and development. At that time, $10,800,000 had been funneled into the effort.

A new make-or-break series of paraglider tests will begin in December at Edwards AFB. These involve a full-scale test of the pyrotechnic sequence that deploys the paraglider. Drop tests from a C-130 will either resolve the "detail failures," such as pyrotechnics that fail to release the wing's cables correctly, or scrub the operation. The tests also will demonstrate control and landing capabilities through two manned flight vehicles. These *Gemini* models will be towed to altitude with the paraglider deployed, and a test pilot will work out the flight characteristics and control problems. If successful, the vehicles may be used later for astronaut training. A helicopter will be the towing vehicle.

- **Future programs**—The nature of future programs after *Apollo* and *Gemini* will determine in large part what modifications are required for center facilities, said Elms. A decision to loft one of the smaller space stations, for instance, would not require expansion of center facilities by any great amount. Sizes of both the two-man zero-gravity station and the modified *Apollo* spacecraft are well within the dimen-





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sions of testing and development facilities designed for the *Apollo* Moonship.

Components for even the large collapsible station could go inside the center's vacuum chambers, for example. The integrity of seals and joints could be tested with little modification, Faget said. The proposed ferry vehicles also are within limits of the chambers and other test equipment designed for the center.

An unknown quantity affecting future MSC facilities is the real possibility of radical discoveries about the nature of the space environment. New information about the Sun's radiation effects in space could force major changes in the multi-million-dollar sunlight simulators planned for the environmental chambers.

"We will have unique facilities here to test manned spacecraft for a variety of programs," Elms said. These can perform the functions required for Project *Apollo* and Project *Gemini*, he said, "but MSC is not a two-project operation."

● **Facility overlap avoided**—Maxime Faget, designer of the *Mercury* spacecraft, said "If we tried to do everything here, we could have a center employing more than 50,000 people. We designed to the limited objective of providing facilities that are not available anywhere else. There will be no large supersonic wind tunnels because Arnold Engineering Development Center at Tullahoma, Tenn., has the nation's best capability in that area."

Propulsion testing is best done at Edwards AFB Flight Research Center. Langley is equipped for lunar landing simulation.

Dr. Gilruth compared the nature of any changes to the basic facilities to those at Langley after World War II. For expenditure of about $10 million to add a slotted throat to the 16-ft. wind tunnel, the engineers achieved a supersonic test environment.

Of immediate interest to contractors, however, will be a flood of facilities requests from FY '64 funds. These have held out in Congress, and so far the Houston-MSC Corps of Engineers office has felt safe in giving advance notice for only one of the five major facilities authorized.

The Corps expects to open bids Dec. 20 on the $2,216,000 mission simulation and training facility. The $1.342-million facility will contain nearly half a million dollars' worth of instrumentation and support equipment in addition to the $10-million *Apollo* mission simulator to be installed by North American Aviation, Inc. The facility should begin operation in mid-summer of 1965 when the astronauts are scheduled to begin flying full-scale simulated Moon missions.

"In addition to the already operating arc jet, the center plans to construct an atmospheric re-entry materials and structure evaluation facility which will take almost $2.7 million in equipment, instrumentation and support facilities. This will handle spacecraft sections as large as 12 in. at the full enthalphy load," Faget said.

The Launch Environment and Antenna Testing Facility, with an estimated total cost of $7.48 million, will have $3.119 million for equipment in the vibration, acoustic, and anechoic chambers. The 125-foot anechoic chamber will be the only one in the U.S. capable of holding the complete *Apollo* spacecraft in an environment simulating the radio and radar characteristics of free space.

● **Vital lab**—Another $3.9 million worth of equipment and instrumentation will go into the proposed $5.8-million Spacecraft Control Technology Laboratory. The high-bay area will

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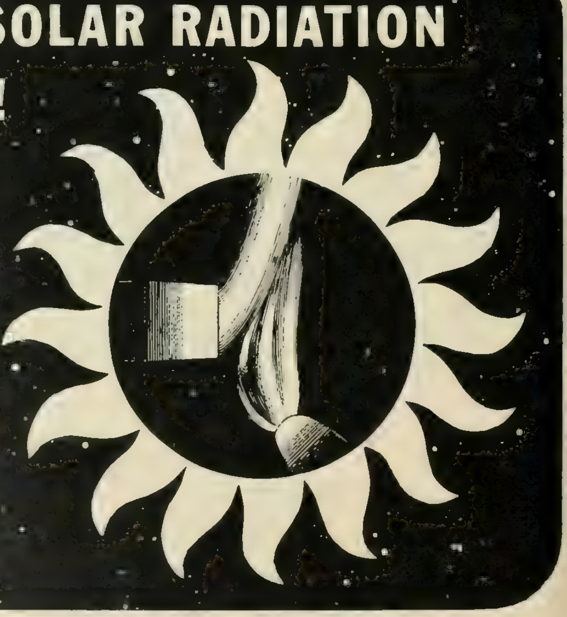

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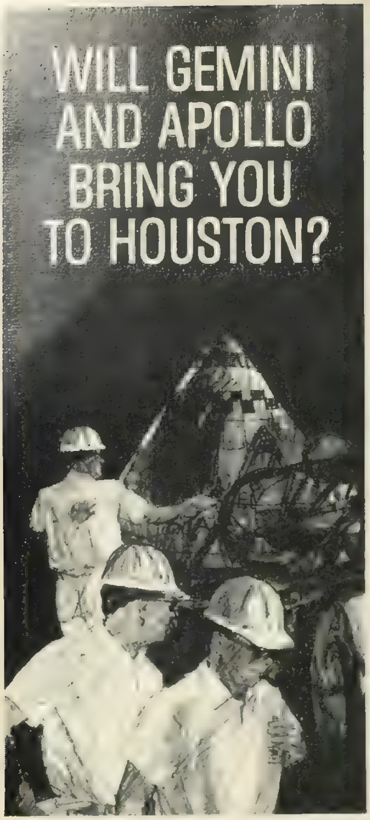
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MSC'S PROJECT MANAGEMENT building nears completion at the Clear Lake site. It is estimated that the total bill for the center will be about $200 million.

have a clear height of 45 feet. A critical facility, it will test spacecraft inertial guidance components, airborne computers, astro-optical systems, and the control and guidance systems. A special projects laboratory will allow astronauts in the command module of *Apollo* to run through simulated mission maneuvers to have their performances evaluated as well as to test adequacy of the equipment for manned control. Visual and motion cues will be fed the crewmen in response to their operation of the control systems.

Theoretical groups will work closely with the "applied" lab men to test procedures for generating and verifying the mathematical inputs predicted for the current and future programs.

Also vital to Project *Apollo*, but not open to much competitive bidding, will be $8.4 million in additions to the Mission Control Center. Philco's Western Development Laboratory already holds the prime contract to equip the center. The FY '64 request covers 55% of the necessary displays and 25% of the simulation equipment needed to control an *Apollo* flight. The MCC is one area in which the 9-12 months saved by scrubbing the first four *Saturn-Apollo* flights will give center officials extra time to develop improved techniques.

Reprogramming in 1963 provided $21,956,700 for the MCC, but this was sufficient only for early manned *Gemini* tracking and control. This will complete the center's capability of tracking one space mission while simulating another on the ground. The center has the capacity for four IBM computers, raising the possibility of handling, eventually, two space missions, a training simulation, and having one computer for standby. The MCC is equipped with emergency power supplies in case the domestic generators or transmission lines fail.

Ultimate MCC cost has been estimated at more than $50 million.

Also delayed by the Congressional debate this year was a six-foot, ultra-high-vacuum facility worth $2.68 million, $1.75 million for simulated space visual displays, a $2.76-million project engineering office building for 560 people, and the center's $15 million request for the Lunar Excursion Module test facility at White Sands Missile Range, N.M.

In two years from ground-breaking, however, the Corps of Engineers and MSC have 54 of the center's 62 buildings and other facilities under construction or authorized. Three of these—the docking simulator, arc jet and radiological testing—are in temporary quarters.

Two of the 62 items in the center's master plan definitely have been dropped for the time being. These are a spacecraft museum and a barge dock on adjoining Clear Lake.

Filling out the master plan would call for only the Flight Crew Building, the cafeteria, another Technical Services Shop and relatively minor additions to the Environmental (Space Chambers) Laboratory. These include a refrigeration building and a central storage facility for the gases used in the environmental facility.

- **Reorganization**—The new organizational lines of responsibility at MSC were announced early in November.

Reporting directly to Gilruth and Dep. Director Elms will be four assistant directors, the *Gemini* and *Apollo* program offices and the Florida Operations office located at Cape Canaveral.

The four assistant directors are:

—Christopher Kraft, Jr., who will head all flight operations. He formerly directed flight operations for Project *Mercury*.

—Maxime Faget, who will be in charge of the engineering and development office, with the added responsibility of subsystem engineering and subsystem contracts. Other engineering and development divisions include: Guidance and Control, Faget, acting chief; Structures and Mechanics, Joseph Kotanchik, chief; Crew Systems, Richard S. Johnston, chief; Instrumentation & Electronics Systems, Barry Graves, acting chief; Advanced Spacecraft Technology, William E. Stoney; and Propulsion & Energy Systems, Alex Bond.

—Donald K. Slayton, formerly director of astronaut activities, who has been named to the new position of Assistant Director for Flight Crew Operations.

—Wesley L. Hjornevick, who will be Assistant Director for Administration. Phillip H. Whitbeck will be his deputy.

The *Apollo* Spacecraft office will be directed by Dr. Joseph Shea, who was formerly Deputy Director for Systems of the Office of Manned Space Flight at NASA headquarters.

Charles W. Mathews will continue as head of the *Gemini* office. ■

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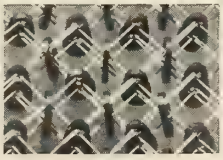

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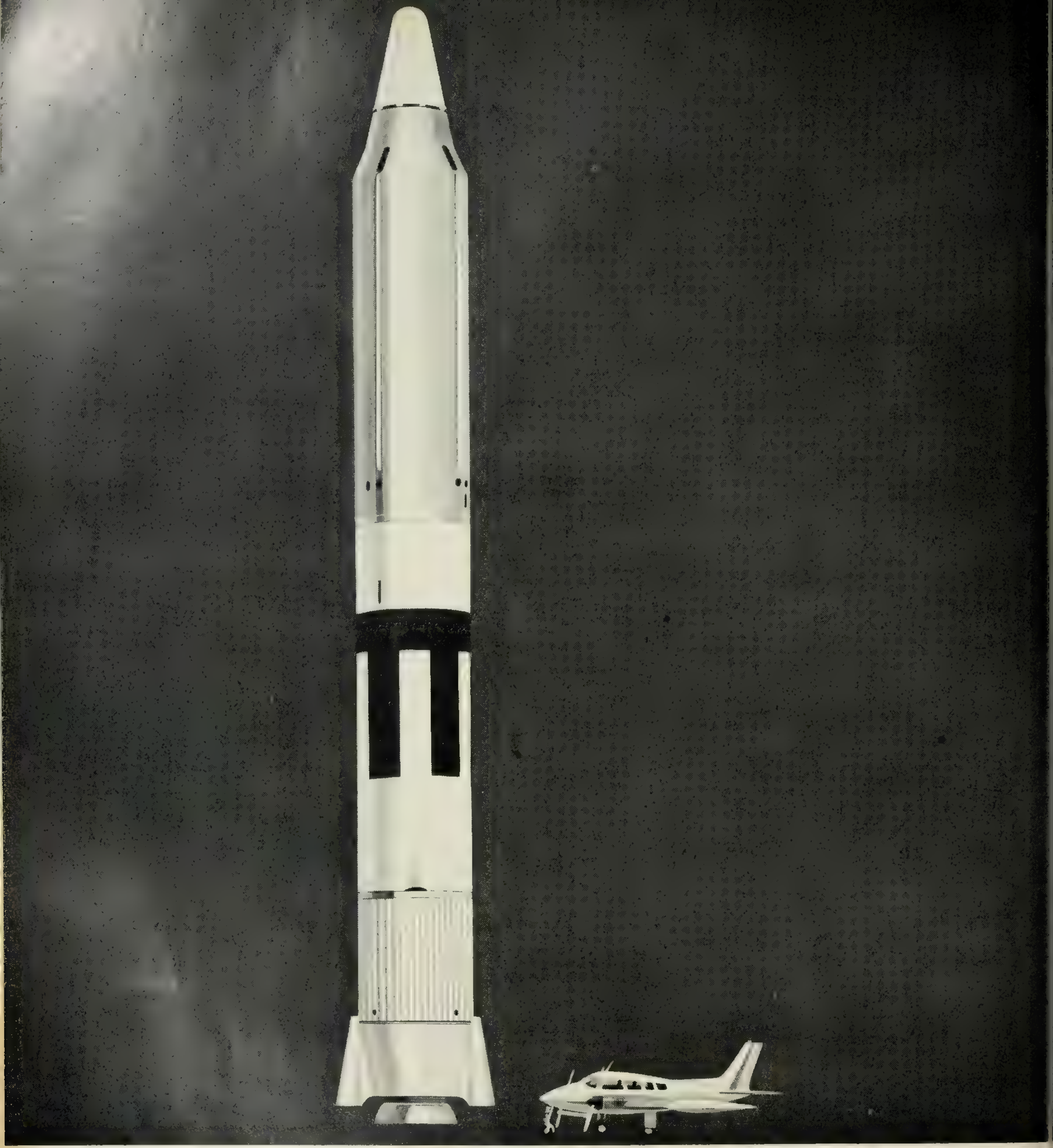

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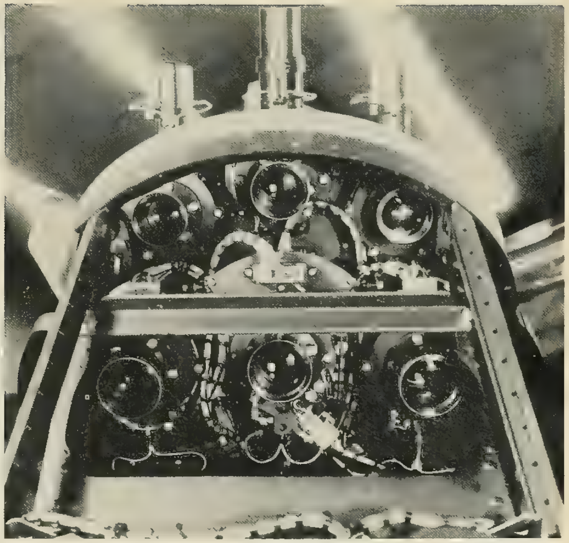


SIX CAMERAS in top of Ranger 6. Four are faced so pictures overlap in composite picture of landing area.

JPL Program Growth Forces Increased Contracting to Industry

Space Flight Operations Facility to serve as nerve center of DSIF, will provide headquarters-wide TV link

PASADENA, CALIF.—Jet Propulsion Laboratory is now contracting to industry nearly 70% of its work, and the percentage is still rising.

This development is part of a trend toward dispersion of projects forced by the fact that the unmanned lunar and interplanetary programs for which the center has been made responsible have become too large to be managed by JPL under its NASA-imposed manpower ceiling of 4,000 personnel.

For several years, JPL policy has dictated that more of the lab's responsibilities be contracted to industry. Now NASA headquarters is pressing a wider dispersal of program management to other centers and to prime contractors in industry.

Projects assigned elsewhere include the *Pioneer* interplanetary probe at Ames Research Center (see p. 204) and Langley's *Lunar Orbiter* (see p. 198). The latter replaces the *Orbiting Surveyor*, which was to have been managed by JPL.

Despite all this, the lab remains the primary center within NASA for unmanned lunar, interplanetary and planetary exploration. Its excellent technical capabilities are likely to keep it in that role, and industry will find it an increasingly fertile source of business.

During recent years the lab has awarded sizable prime contracts for development of the *Surveyor* soft-landing lunar spacecraft and the *Ranger* block 5 hard-lander.

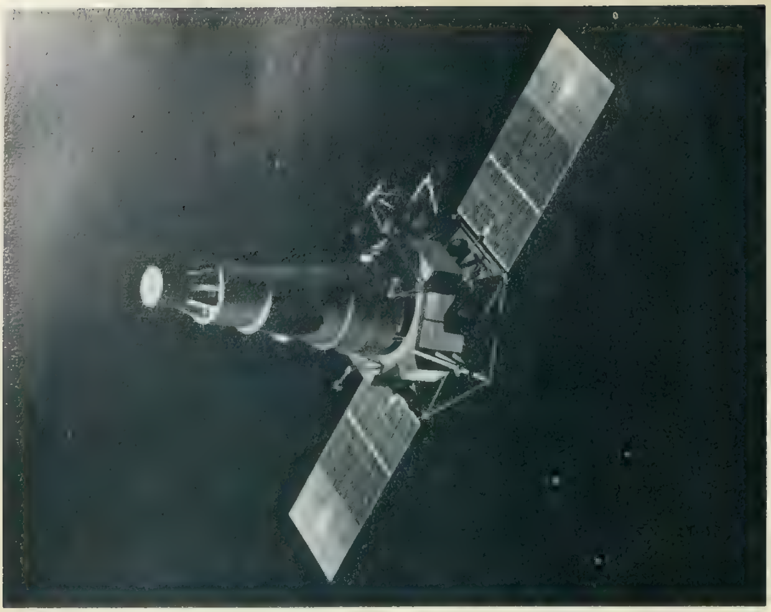
- **Strange animal**—Close observers feel that the peculiar status of JPL is a source of weakness in contending for NASA programs. The lab has responsibilities that are equivalent to those of a NASA center, but it is not officially a part of the agency. It is a part of a university, California Institute of Technology, but has no serious academic function; it is officially a contractor, yet its responsibilities are much broader and more comprehensive than those of any contractor in the history of the missile/space program.

Those who are pessimistic about the future of the lab can say that bureaucratic empire builders will fight JPL as an outsider. At the same time, some industry executives complain that the lab, which now supervises them and has access to their trade secrets, will begin to compete with them if the space program comes on lean times. JPL officials counter with the argument that they are competing with neither the centers nor private enterprise; they contend that their independence of stockholders and civil service hierarchies gives the lab greater efficiency as well as lower costs.

- **Ranger complications**—The conclusion that management of all U.S. unmanned lunar, interplanetary and planetary programs was beginning to overextend JPL was an important factor in the decision to award a prime contract for the development of the *Ranger* block 5 system to Northrop Space Laboratories.

Block 4 has been eliminated from the program and JPL will continue to run the block 3 phase directly. The block 3 spacecraft will be the next to fly in the unmanned program and will carry television cameras to shoot pictures of the lunar surface as they fall to their destruction. Block 5 spacecraft will carry a hard-landed payload that has not been finally selected. It is a second attempt to attain the goals originally set for block 2.

There were 120 Northrop people assigned to work at JPL on block 3 as training for their responsibilities on block 5. Most of them have now completed this phase and returned to their own plant. JPL has a staff of 450 engineers working on the system. The complete on-board power subsystems for block 3 spacecraft are being tested under contract by Electro-Optical Systems, Inc.



RANGER 6, newest in trouble-plagued JPL-managed series of lunar hard-landing spacecraft, is scheduled for launching in first quarter of 1964.

The balsa-cased seismograph designed for *Ranger* block 2 by Aeronutronic Div. of Philco is generally regarded as the most likely payload choice for block 5, but a hard-landed television camera and other payloads are also being considered. JPL officials report that in the engineering of block 5 systems, Northrop has the initiative for changes as prime contractor, but JPL retains the veto as contracting agency. Funding for block 5 is still classed as uncertain.

Among the repercussions of failures in the *Ranger* blocks 1 and 2 was a merger of the JPL Lunar Program Office with the more successful Planetary Program Office, an increase in the quality-assurance staff from one man to 100 men and a strengthening of project organization lines within the JPL staff. The purpose is to improve management control by preventing engineers from cutting across organizational boundaries at will to work on more than one project. It is expected to eliminate uncertainty about how the resources of the lab are spent and improve the reliability of schedules and cost estimates.

JPL administrators admit that tighter project lines will slightly diminish the efficiency and responsiveness of the staff, but they regard the need for effective control as more important. The basic organizational concept of the lab remains unchanged. The technical staff is grouped in seven divisions according to technical discipline. Project offices are the focal points for the activities of technical division personnel leading to a flight project.

DSIF and SFOF

An active part of JPL is the Deep Space Instrumentation Facility (DSIF) and the Space Flight Operations Facility (SFOF) now taking shape as nerve center of the DSIF.

The DSIF consists mainly of the three big tracking, telemetry and command installations at Goldstone, Calif., Johannesburg, South Africa, and Woomera, Australia. Capability of the DSIF will soon be increased sevenfold by the installation of 210-ft. parabolic antennas at all three sites. This capability will not be matched in the immediate future by any other integrated network of installations in the West. It also is the only one conceived with the intention of tracking and controlling spacecraft at interplanetary distances.

The SFOF at the Pasadena headquarters of JPL is one of the most elaborate and ingenious of the command and control centers now being prepared to operate space vehicles. One of its features is an 18-ft.-dia. astrodome in which a functional model of spacecraft can be installed and manipulated so that control room operators can visualize spacecraft maneuvers against the celestial sphere before the actual maneuver command is transmitted to the vehicle.

● **Elaborate TV**—The SFOF will possess the most comprehensive closed-circuit television network created to date. About 200 monitors and 100 cameras will be controlled by a crossbar switching system so that channels can be selected by something like a telephone dialing arrangement. There will even be area surveillance cameras so that supervisors can dial to search for employees who are not at their posts.

The network will be used as a cheap and simple way to route teletype read-out to many people. Remote printers would be less flexible and more costly. Other channels will be used to provide video-phone connections so that important personnel can carry on face-to-face conversations from remote locations and perhaps show each other sketches to make a point. Some classes of information which can be shown in a preselected format will be generated within the TV system. To provide flexible routing for all the cables required by the system, everything in the facility rests on a carpeted false floor 18 in. above the concrete structural floor. Thus, TV cameras and monitors can be relocated anywhere in the center without any trouble. The space also serves as an air-conditioning plenum.

Primary types of information needed for decision-making on unmanned space missions will be presented to spacecraft controllers by 10 display modules high on the wall of the control room. JPL engineers built these in the lab for $40,000 after finding that it would cost $400,000 to buy them from industry.

● **No computer drives yet**—None of the displays are computer-driven. The JPL facility designers believe that computer-driven displays can be made to work, but they do not believe that they are practical for operational use at this time. They report that military command and control centers originally equipped with computer-driven displays are now removing them. JPL officials believe that the more elaborate displays are inherently less flexible and adaptable. There is also a cost angle. JPL estimates that the total cost of a computerized system would be about $6 million, instead of the $1 million being spent on the non-computer systems.

The SFOF was designed with the intent of adopting computer-driven displays when JPL scientists are persuaded of their practicality. At the end of the first year of operation, JPL will award a computerized display study contract after competitive bidding.

A pair of IBM 7094 computers will reduce data with a pair of IBM 7040 computers acting as input-output devices. The three big DSIF antennas will be wired directly to the computer center in Pasadena via high-speed data lines so that information from spacecraft can be received and processed without any intervening human operations.

Paired computers are intended to permit a parallel back-up. This means that data-reduction operations would be conducted simultaneously on both sets

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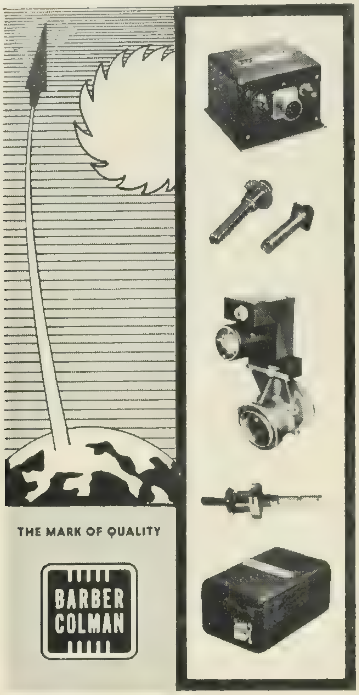

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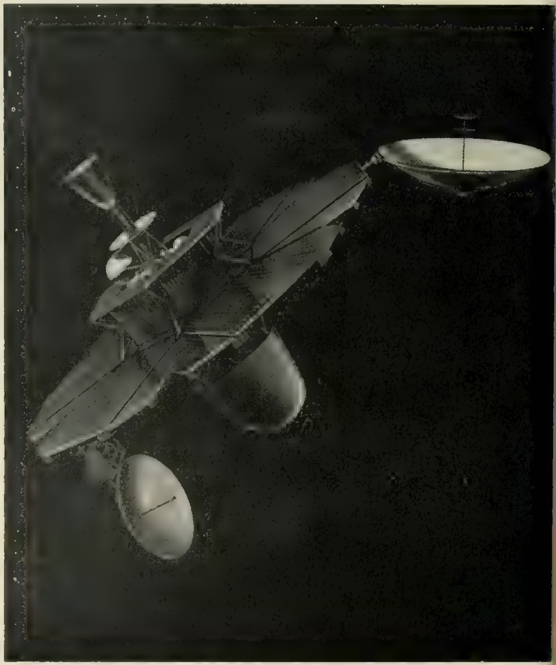
so that no time need be lost re-running part of the data in event of a breakdown. If it is felt safe to operate without parallel back-up, the system can handle four spacecraft. Otherwise, the limit is two. The computer complex will not be finished in time for the *Mariner C* Mars mission and the SFOF will have to get along with a single 7094.

The machines are operated from a single control room. Nine inquiry stations are located at various places in the SFOF where assistants can feed problems to the machines and receive answers without the assistance of programmers. While slight format and language restrictions must be observed, the inquiry stations function generally in the language of the analyst and not that of a programmer. The analyst cannot use programs other than those already stored, and it is impossible to insert new programs from the inquiry stations.

• **Vying for jobs**—The SFOF is scheduled to open for business in April, 1964. In 1965, other spacecraft control centers will open, including the flight operations facility at Goddard Space Flight Center and the integrated mission control center for *Apollo* at the Houston Manned Spacecraft Center. A certain amount of competition for projects can be anticipated.

Mariner C, *Ranger* block 5 and *Surveyor* are the first firm programs for the SFOF. The DSIF is committed to support of *Pioneer*, but use of the SFOF is still the subject of discussions. The request for proposals for Langley's *Lunar Orbiter* specifies that it will be controlled from JPL SFOF. However, lab officials believe this was a hasty announcement. They expect a drive withi NASA to get the project into the facility being constructed at Goddard.



DRAWING of JPL concept of Voyager unmanned interplanetary spacecraft, for which the lab is prime contractor.

Ranger block 3 missions should sli
into 1965, it is possible that the la
two will be conducted from the SFO
but under no circumstances will t
first two be controlled from there.

The first of the big new DSIF a
tennas will not be ready for the launc
of *Mariner C*. However, if schedules a
met, it should be in service at about t
time the spacecraft reaches midcour
on its seven-month journey. Missi
plans are based upon the present 85-
dishes, but if it is ready in time, t
new equipment may be used to iss
commands to the spacecraft during t
latter part of the mission.

Total cost of the SFOF will
nearly $15 million.

• **R&D requirements**—JPL tec
nologists believe research and develo
ment progress is needed in these area

—Spacecraft attitude-stabilizati
systems.

—Long-range and relay communic
tion systems.

—Reliability techniques.

—Materials capable of survivi

the environment in a solar orbit at a distance of 0.1 AU.

—Polymers for use aboard spacecraft which will not out-gas in the vacuum of space or be de-polymerized by ionizing radiation.

—High-speed interplanetary gas dynamics and thermodynamics.

—Solar thermionic systems for long-duration planetary spacecraft.

—Packaging of electromechanical systems to survive rough-landing missions to Mars.

—Superconductive cryogenic gyros.

—Electrostatic gyros.

—Solar-spectrum determination for the purpose of designing spacecraft heat-control systems.

—Advanced RF tracking systems for use with large-aperture inflatable or erectable spacecraft antennas.

Advanced concept work at JPL includes a parallel logic computer for spacecraft which is well along in development, nuclear-electric spacecraft power systems and investigation of gaseous core reactor concepts for nuclear rockets. The lab is developing integrated S-band receivers evolved from DSIF equipment for use in *Apollo.*

JPL has just received design proposals from industry for a spacecraft TV ground-data handling system as part of lunar soft-landing Project *Surveyor.* However, the functioning of the system is largely independent of mission. It will be used for *Mariner C* and obviously would be valuable in Langley's *Lunar Orbiter* program. Since it will not be built until June, 1965, it will not be available in time for *Ranger.*

● **Doubling lifetime**—Long-term unattended reliability remains a pressing requirement for unmanned space programs. The technological race to keep up with mission objectives is a desperate one. The experience of U.S. and Russion interplanetary missions indicates that the lifetime of spacecraft systems in the present state of the art is about 3,000 hours. For the *Mariner C* Mars mission, JPL must obtain twice that lifetime. The JPL technical divisions are reasonably confident that they can do it with the additional time and money they have put into the effort since the successful Venus mission of *Mariner 2.*

The *Mariner C* attitude-control system will be much like that of *Mariner 2* except that the Earth tracker will be replaced by one tracking the star Canopus. The change will give greater freedom in selecting launch time. During part of the Mars mission, the Earth will be nearly dark against the solar disk. Canopus is in the southern half of the celestial sphere and its brilliance will be constant all the way from Earth to Mars. The Canopus tracker is also to be used in Project *Surveyor.* ■

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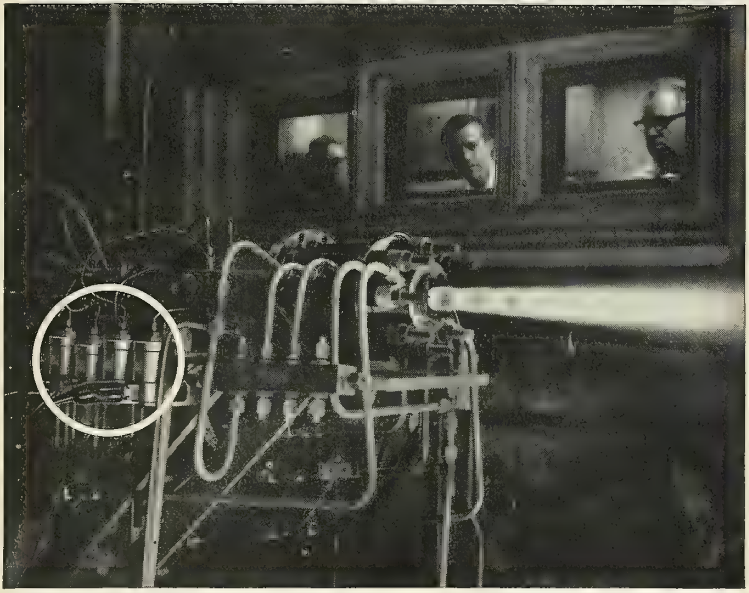

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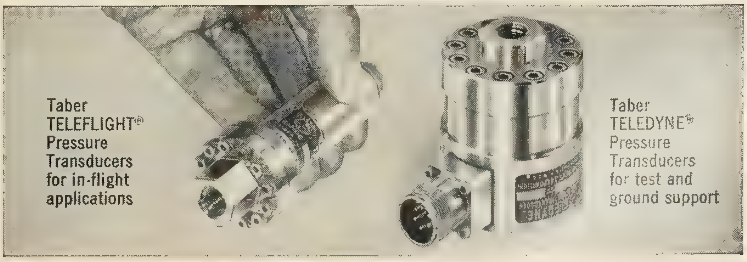
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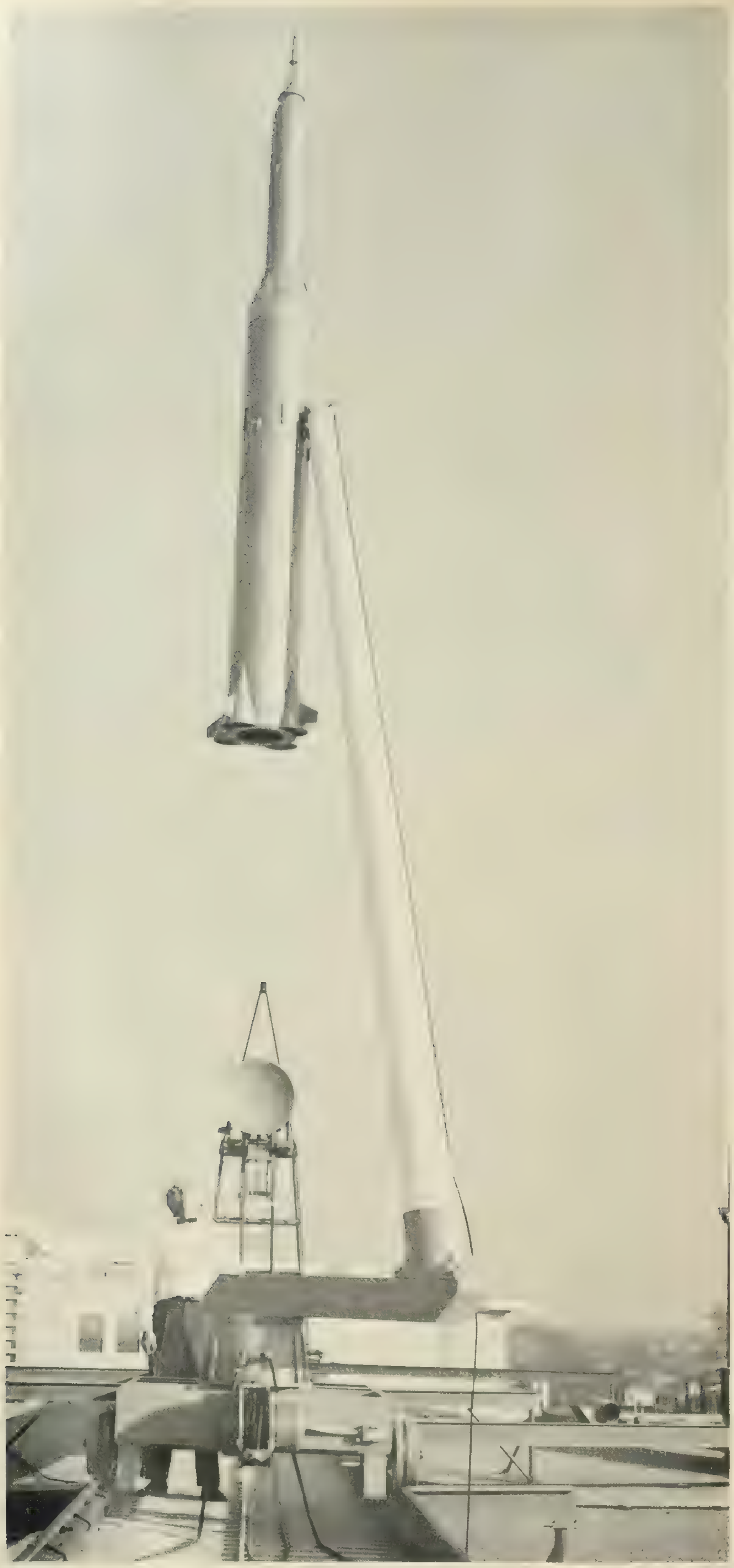


LEFT: North American Aviation engineer prepares to operate 1/25 scale model of Saturn V. Dish antenna in background will transmit to vehicle receiver to test performance of telemetry, communications and radio beacon antennas. Booster will be fired from LOC. RIGHT: Saturn V Complex 36B under construction at LOC. FAR RIGHT: Artist's conception of Saturn V ready to fire Apollo spacecraft from Merritt Island Launch Area.

NASA /installation

Hybrid Nov

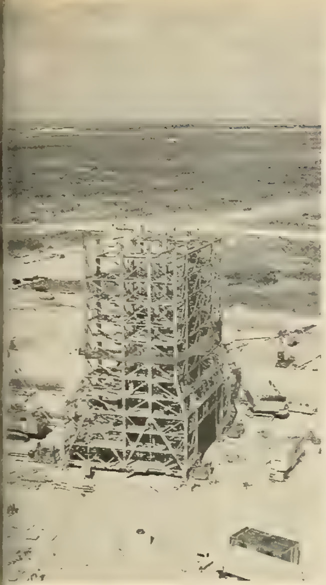
CAPE CANAVERAL—Planners at the Launch Operations Center now favor a hybrid launch complex for the *Nova* booster.

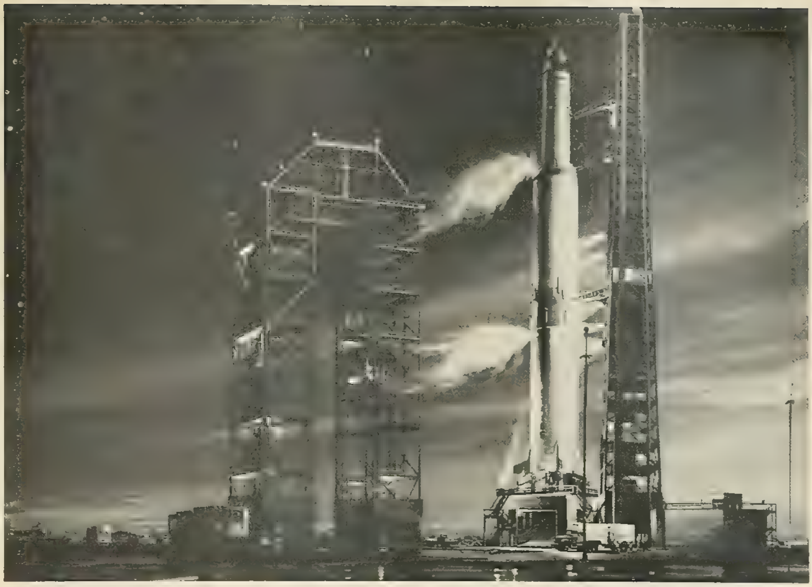
The structure, with a cost of hundreds of millions of dollars, would consist of a stage checkout in a low bay assembly in a building and launch through the top after the roof had been removed to one side.

Emphasizing that all *Nova* effort here is simply studies, the officials report that the hybrid system is favored because it would provide environmental protection and make the booster secure from overpressures in case of a nearby disaster.

The environmental protection is important because cryogenices are expected to boil off the big booster a 10,000 gpm.

The officials also believe that there will be no need to go to off shore launch facilities. They insist the Merritt Island





aunch Complex avored at Launch Operations Center

ter officials striving to make Merritt Island Launch Area able of firing any booster or spacecraft currently under elopment; budget cuts won't appreciably hurt construction

aunch area (MILA) is sufficient to protect other launch complexes and the populated mainland from acoustical pressures and blast effects.

While officials here are studying the tasks they may be performing in the late 1960-early 1970 time period for development of *Nova*, they are pushing a massive program to give MILA the capability of checking out and launching any booster or spacecraft now under development.

• **Construction tab**—The bill for this tremendous undertaking, which includes the largest construction job now under way in the United States, will run to at least $750 million after "brick and mortar" work is finished and all ground-support equipment is installed.

The U.S. Army Corps of Engineers, which serves as construction contracting and supervising agent for NASA here, had $83,265,000 worth of "brick and mortar" work under way or completed by Nov. 1. The figure is scheduled to rise to $190,525,000 by the end of January, 1964.

Contracts awarded before Nov. 1 covered work on Complexes 34, 36B, 37 and portions of Complex 39. The latter included portions of the Vertical Assembly Building (VAB) for *Saturn V*, a railroad system to serve the industrial and launch areas of Merritt Island, plus roads and utilities.

Also under contract were most of the buildings for the industrial complex, the Manned Spacecraft Center's operations and checkout building, and an extensive network of roads, causeways and barge canals to service the entire area.

While the construction program gets some attention from LOC, personnel also are performing normal checkout and launch operations and conducting studies to meet future requirements for launch facilities.

The driving force behind this extensive and complex program is Dr. Kurt Debus, director of LOC and a member of the *V-2* group that worked at Peenemuende during World War II.

• **Ready for Saturn V**—Dr. Debus told MISSILES AND ROCKETS he is confident the current expansion program will produce facilities ready for operation by the time the first *Saturn V* is delivered to the Merritt Island launch area by mid-1965, but he added an "if" in discussing the matter.

"Construction of facilities depends on authorized appropriations," he said.

He estimated the proposed Congressional cut from $312 to $279 million in construction of facility funds for Fiscal '64 will not appreciably hurt development of the center.

"Congress considered all our requests valid but questioned our ability to spend all of it," he declared, adding "we have been slow in the past."

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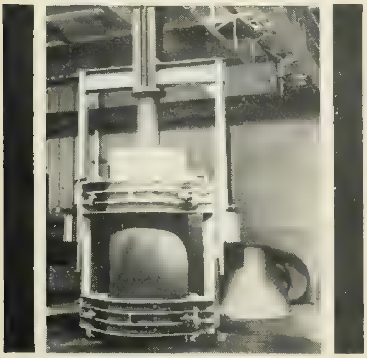

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● **Fund shifting authorized**—"However, the committee considering the budget has given an okay for us to shift funds where we feel they are needed."

He said this will permit the center to meet sudden shifts in priorities and programs such as the recent cancellation of six *Saturn I* flights and the sudden requirement to convert *Saturn I* launch pads to handle the more advanced *Saturn IB*.

"The conversion of Complexes 34 and 37 will consist of adding some automated control equipment in the blockhouse and installing different arms on the umbilical mast to meet changes in connector levels on the *IB*," Dr. Debus said.

"There also will be some small changes in the service tower such as the location of some cables and connectors but there will not be a requirement for a change in the cryogenic handling systems."

Turning again to the budget, Dr. Debus said the center now has money for two launch pads on Complex 39 and to equip two of the four bays in the VAB where the *Saturn V* will be assembled and prepared for launch.

"As the program progresses, we may have to ask for a third pad and money to equip more bays in the VAB and to construct a building for the RIFT stage," he said.

● **Stabilization foreseen**—But he predicted annual spending would level out at about $200 million after the current construction of facilities is completed.

Personnel will stabilize at about 13,000 in five years with 4,000 civil service workers and 9,000 contractor employees. The civil service group would include people assigned to Goddard and the Manned Space Flight Center but stationed permanently at LOC for operational activities.

Lt. Col. Rocco Petrone, chief of the

LOC Fiscal 1965 Study Programs

Special solid-propellant hazards analysis—To define special hazards and recommend safe operating procedures and equipment, particularly in the field of toxicity of exhaust gases.

Launch probability analysis—To devise methods of pre-determining the expected launch probability of future space vehicles of any class or type.

High-pressure gas storage, transfer and utilization techniques—To optimize storage and transfer techniques on Earth to reduce expenses and to determine the most effective, reliable and least costly methods of gas storage in orbit for orbital launch operations.

Reduction of vehicle and GSE electrical and mechanical tolerances—To identify unnecessarily close tolerances on vehicles and ground support equipment to reduce costs.

Firing accessories and umbilical concepts—To reveal new, reliable and economical firing accessories and umbilical concepts to meet demands of larger and more complex vehicles.

Alternate launch sites studies—To examine costs, logistics and growth potential of selected alternate land-based launch sites within and without the continental United States to select one or more attractive sites to supplement the Atlantic Missile Range.

Investigation of initial orbital launching facilities—To investigate methods and requirements for launching a vehicle from an orbiting space station.

Integration of special nuclear stage requirements on launch facility and operational plans—To identify and plan for the special facilities, equipment and operations required to support a nuclear-staged space vehicle. Preliminary study efforts are required in the areas of failure effect analysis for all conceivable launch modes, engine assembly, handling and checkout requirements.

Feasibility of offshore launch facilities for large vehicles—This study to be performed in the expectation vehicles may soon exceed land limits of Cape Canaveral and vicinity.

Communications and RF camera control system study—To determine the feasibility of, and, if feasible, provide the design and cost of a complete system of controlled, closed-circuit TV at strategic locations around launch complexes for distribution to remote locations at Canaveral, Huntsville, Washington, Houston, etc.

Service structure concepts study—To investigate new service concepts and methods of modifying structures to increase versatility and operational capability and to support changing vehicle configurations.

center's Heavy Space Vehicles Systems Office, told M/R that Complex 39 has been designed as a very flexible facility to meet any possible launch requirements in the foreseeable future.

"We see no need at this time for new facilities," Col. Petrone said, "but we may have to add a third pad on 39 or go to six bays in the VAB."

He explained that the extra bays might be used for assembling *Saturn IB* vehicles on specially designed Launcher-Umbilical-Transporters (LUT) for launching from Complex 39 pads.

Col. Petrone said development of a "universal third stage" for the *IB* could give the intermediate vehicle the capability of sending large payloads to the vicinity of Mars and Venus.

- **Ten IB shots a year**—"We can easily handle 10 *IB*'s on 34 and 37 but if we go to more than 10 or 12 a year, we could put the overflow on 39," he said.

A contract is now out to Reynolds-Smith-Hill to do the design criteria for the smaller LUT, since the difference in size and connections would rule out use of the *Saturn V* LUT for launching the *IB* with an adapter ring. The *Saturn V* has a 33-ft. diameter, while *Saturn IB* measures 21.6 ft. across the base.

Col. Petrone said a decision to activate a third pad on Complex 39 "probably is a long way off" but added that a decision to use any form of Earth-orbit rendezvous could speed this decision and have an effect on building a fourth pad for Complex 39.

"Pads A and B are needed for the *Saturn V* Manned Lunar Landing Program, but if the *IB*'s go beyond 10 a year, the rate will determine when the third pad must be built," he said. He added that the third pad is designed and the location of a fourth pad already has been fixed.

"If we use the rendezvous plan, we will need large payloads and propulsion." Col. Petrone said.

"That would call for three boosters on the pad at the same time. The possibility of losing a booster on the pad could be reason for constructing the fourth pad as a backup."

He said the rendezvous technique with the *Saturn V* might be required for trips to the planets if NASA should abandon the *Nova* concept.

- **Nova sites selected**—Col. Petrone said as far as *Nova* is concerned, the land is available and the three *Nova* launch pads have been tentatively located along the oceanfront several miles north of Complex 39. Each *Nova* is separated by more than three miles.

The decision to proceed or drop the *Nova* booster concept is in the hands of Marshall Space Flight Center, but LOC is keeping pace with developments and

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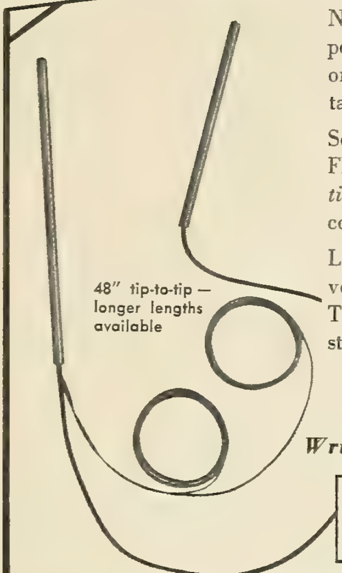

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studying requirements for launching the super booster if and when it becomes available.

This work is being done by the Future Studies Branch (FSB) of LOC's Launch Support Equipment Engineering Division. FSB is located in Huntsville, Ala., at MSFC.

The small 13-man unit is headed by Georg von Tiesenhausen, also a member of the Peenemuende team that moved with Wernher von Braun from the Army to NASA in 1960.

Von Tiesenhausen told MISSILES AND ROCKETS the *Nova* launch facility study comprises only a small part of the work done by his staff, which manages a great number of study contracts.

- **FSB organization**—He said Future Studies Branch is divided into the two areas of supporting technology and advanced studies.

"Supporting technology must anticipate technological bottlenecks while advanced studies is just that and covers ground, orbital and lunar launch operations."

Supporting technology studies such things as the *Saturn* holddown and release equipment, methods of launching, materials to use in launch facilities and processes required to accomplish the launch.

The advanced studies phase of his operation covers facilities, checkout and equipment concepts for the various launch operations on Earth and in space.

The FSB office, which worked on the Complex 39 concept first, has been engaged in a study of the *Nova* launch facility for the past two years and provides "a test bed for all new problems of launching."

"But if someone wants *Nova* by 1975, we will have the information for them," von Tiesenhausen said.

He said this would be possible through a continuous process of updating the work each year to remain abreast of work being done on the *Nova* concept by MSFC contractors.

Von Tiesenhausen said four *Nova* vehicle concepts are under consideration at the moment and MSFC and his group help each other "by pointing out what can't be done."

- **Nova launch method flexible**—"Since neither mission nor payload has been assigned to *Nova*, it is difficult to identify the vehicle," he said. "However, the launch technique can be either fixed, mobile or hybrid."

He explained the mobile concept would employ an LUT and the fixed would go from a launch pad like Complex 34.

The hybrid method is in greatest favor because it would provide environmental protection.

Studies of the RIFT effort have been under way at FSB for the past two years. Von Tiesenhausen said that since the first test flights are now set for 1970 or 1971, LOC must come up with its final concept of the stage-handling structure by 1967 and construct and integrate the facility into Complex 39 by about 1968.

- **RIFT facility described**—Present thinking indicates no great changes must be made and von Tiesenhausen predicts the RIFT stage building will have similar construction to that used on the VAB.

He said it will be a separate structure where there will be some pre-flight tests but no runup of the stage engine. The engine will be delivered to Complex 39 in a "safed" condition and this will not be removed until the stage is safely in orbit.

FSB also is working on the AOLO (Advanced Orbital Launch Operations) that will extrapolate experiences in ground checkout for application to SCALE (Space Checkout And Launch Equipment).

Von Tiesenhausen explained ground checkout of a launch is accomplished by 150 persons using from 1,000 to 2,000 cables and vast amounts of equipment.

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"We can't take all this equipment and people into space," he said.

Industry is being approached to determine how much of the equipment can be made compact and reliable enough to do the job. The investigations include a look at lasers, microcircuitry, solid state and other advances in an effort to come up with an answer.

The office also is working on lunar mobility and this centers around the *ALLS (Apollo Lunar Logistic Support)* vehicle. It is due to be carried to the lunar surface by a modified Lunar Excursion Module letdown unit.

Von Tiesenhausen said the vehicle has no fixed design at the moment and several types of wheels and power supplies are being considered. Final determination of design probably will rest on data returned from the lunar surface by unmanned exploratory spacecraft during the next few years.

- **LOC studies listed**—LOC has several studies under way, which are administered by the FSB, and are carried on both in-house and out-of-house.

The in-house studies being conducted at Huntsville include a lunar logistic system, contract work statements, advanced orbital operations, exotic propellant facilities, supporting technology and advanced studies control handbook, high-pressure gas storage, launch facility nuclear safety, thermal design of launch deflectors and over-water jet impingement.

Out-of-house studies for the current year are facility concepts for large thrust vehicles, leak-detection methods, reduction of liquid hydrogen boiloff rates, helium use and re-use techniques, advanced launcher and deflector related studies, special launch support equipment and facilities required for future missions, cryogenic propellant storage and transfer techniques, high-pressure-high-flow-rate flexible hoses and couplings, improved launch site assembly and checkout techniques, facilities for solid propellant vehicles, and launch facilities for orbital operations.

Von Tiesenhausen said the ratio of in-house to out-of-house studies is about 1 to 10. The branch expects to spend about 10,000 manhours on the in-house studies this year while contractors making studies will use up 100,000 manhours.

He said his office has many contacts in industry and keeps abreast of the capabilities and facilities in various companies so FSB can quickly determine which firm can give the best results on a study contract.

- **The farther future**—But not all the looking to the future is done in LOC's Huntsville office.

Dr. Debus not only keeps abreast of current operations but spends many hours studying the future.

"I expect we will continue to work with solids and closely watch what is being done with *Titan III*," he said.

"By 1975, I think we will be on the way to development of a launch vehicle of 30 to 40 million pounds thrust."

He said such a booster would be required for the Mars manned mission.

He also looks for a steady increase in the number and scope of unmanned scientific satellites as the years pass and by 1975 "we should be making logistic supply landings of all kinds at a lunar base."

"There may be a more vigorous military mission in space for satellite inspection and similar activities," he predicted.

"I also expect to see a manned space station effort done jointly by NASA and the Department of Defense with the aim of acquiring scientific knowledge."

Asked about the recent Russian declaration of abandoning a lunar landing effort, Dr. Debus smiled and said, "I can't see how we can afford to slow down. In fact, I expect our space effort to increase." ■

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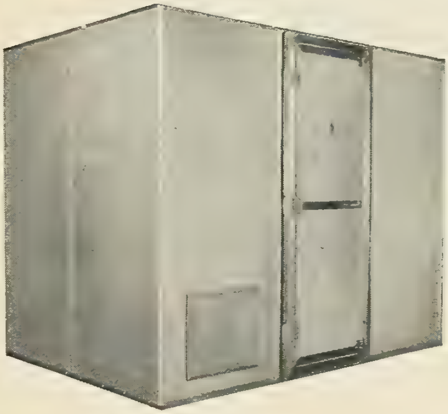

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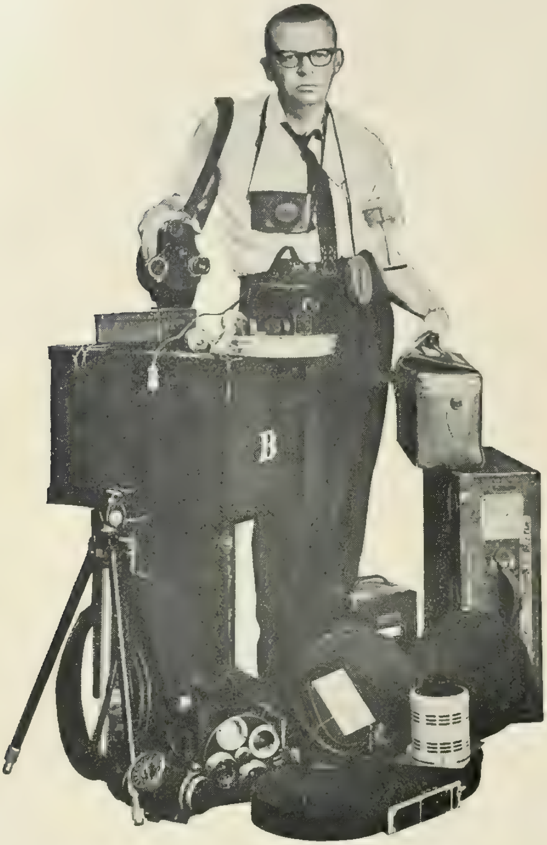

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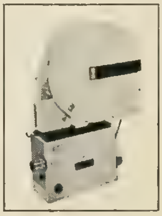

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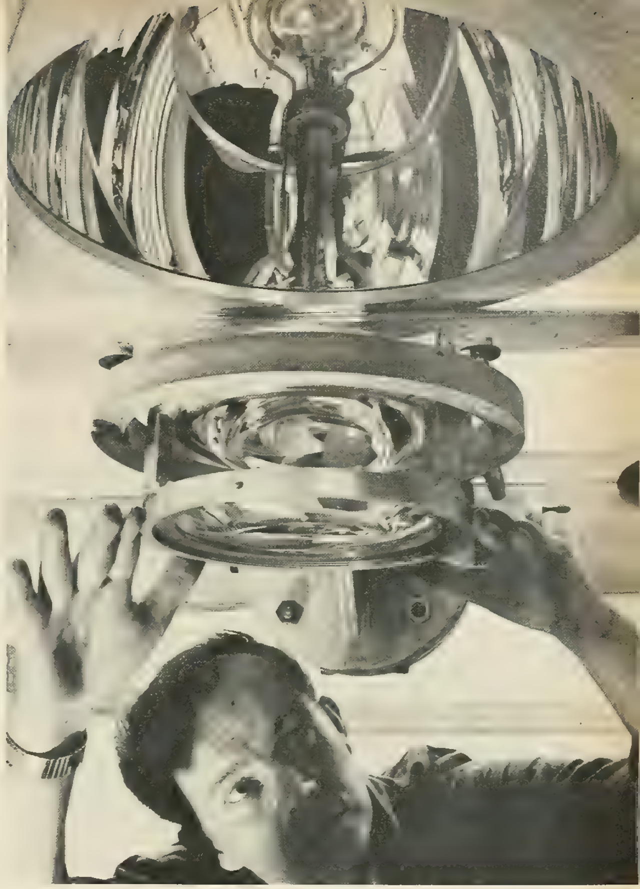
Goddard Aims To Build Even Bigger Test Facilities

No new major projects in sight during FY '65, but personnel will increase; a look at plans for new test plants



SIX-STORY environmental space chamber will use 127 of these 2,500-watt Honeywell mercury-xenon short arc lamps.

GREENBELT, MD.—"We hope to help maintain the U.S. lead in meteorology and communications and, of course, continue emphasis on our scientific satellite effort," said Eugene W. Wasielewski, summing up Goddard Space Flight Center's overall position for the coming year.

A constant level of effort through FY 1965 will be maintained, the Goddard associate director asserted, and no new major projects are envisioned.

Although personnel requirements are temporarily leveling off (about 3,400), the observatory-type satellite programs are approaching their peak in demands for engineering and scientific support, he disclosed, forcing a future (FY 1965) personnel expansion.

The greatest changes occurring at this extensive R&D center are in new facilities required to support the advanced spacecraft programs. Construction of an isolated hazardous test facility, modernized payload test facility and a mechanical test facility, plus three new laboratories (for data interpretation, quality assurance and meteorological systems) comprise the chief needs in Goddard's Fiscal '64 budget request.

The Congressional authorization of $17 million was $4 million below that requested for GSFC facilities construction.

From FY '63 money, Goddard will soon build three test facilities unmatched certainly anywhere in the Free World: the Launch Phase Simulator, a 165-ft.-dia. centrifuge capable of reproducing the mechanical loading and acoustical vibrations experienced by unmanned payloads during launch and atmospheric flight; and two magnetic facilities, using 20-ft. and 40-ft.-dia. Helmholtz coils capable of producing rotating fields.

Goddard's gigantic $15-million environmental test-chamber facility will be virtually complete with the installation and test of the solar radiator. Two 35 x 60 ft. chambers are capable of attaining vacuums to 10^{-8} torr. One chamber, used for solar simulation, employs 127 individual 2,500-watt mercury-xenon short-arc lamps mounted in the chamber dome.

Pressing the state-of-the-art, the solar simulator has been designed to accommodate 5,000-watt light sources. This facility is expected to be operational within three months.

For the future, Goddard scientists have indicated two other pressing needs: a radiation environmental test facility and a thermal test chamber. The latter may become an addition to the Launch Phase Simulator; however, the technical problems of very rapid temperature cycling over a very wide range will have to be solved first.

- **R&D up to $100 million?**—Goddard's R&D authorization of $368.5 million for FY '64 is a sizeable increase over last year's $269 million. However, the NASA FY '64 appropriation may be over $150 million below that authorized, and many expect that cuts will be applied primarily to NASA's unmanned programs. If so, Goddard's application and scientific satellite programs probably will be severely cut back.

- **Communications, tracking and ADP**—Goddard is continuing the orderly expansion and augmentation of its global tracking and communications networks. The new Range and Range Rate System is coming into operation, the addition of PCM telemetry, FM/FM telemetry receiving equipment, S-band radars, plus telecommunications channels to the Houston Mission Control Center, are being scheduled for installation in time to support the *Gemini* and *Apollo* manned space programs.

Two problem areas still exist, however. One is the question of instrumentation-ship responsibility. As many as five tracking and telemetry vessels will be needed for the manned flight programs. If NASA is assigned the task of program management, Goddard will be charged with directing the effort and thus would require a major expansion in technical personnel and facilities.

The other problem emanates from Goddard's far-flung communications net. As might be expected, the rapid expansion over the past five years of the network has left gaps and resulted in system incompatibilities (particularly with respect to the Defense Communication System, although, said one informant, the State Department shudders at any reference to a unification of DOD and NASA telecommunications).

Page Communications Engineers, Inc., has been awarded a $425,000 study contract to survey NASA's global telecommunications net. The goal of this effort is to evaluate what now exists and provide recommendations to Goddard for tightening, automating and unifying the system (called NASCOM).

The extensive data-processing center at GSFC is believed by center officials to be adequate now for at least the next several years. Personnel have leveled off, and the large scientific computers (IBM-7090's) are being operated at a fairly constant 120-140 hours per week on a three-shift basis. Backlog is moderate. Data storage still continues to be a problem.

NEW TEST FACILITIES

Goddard enjoys the benefit of being one of the few major NASA research centers evolving out of the national space effort that has been built literally from the ground up, without the shackles of old facilities carried over from another technology. Five years old, Goddard spent its early years raising the buildings necessary to house its personnel.

Two years ago, GSFC began in earnest the design and construction of its much-needed and highly specialized test facilities.

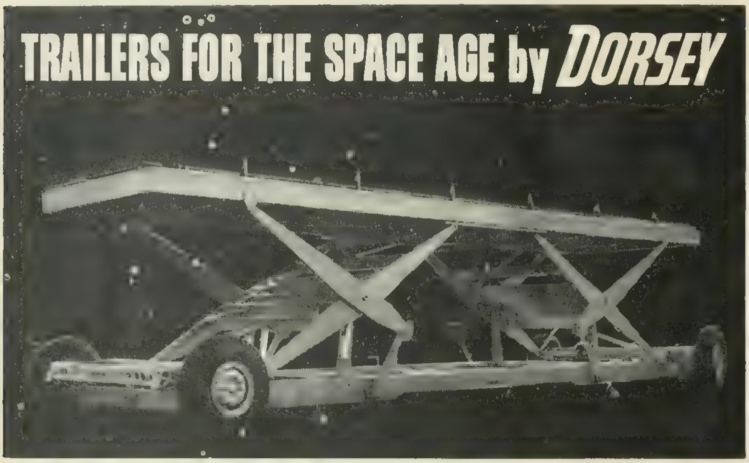
But much remains to be done. Funds for a radiation environmental-test facility will be requested within two years. Such a chamber will have to be separate from existing chambers because of the contamination dangers, and it will have to be large enough to test whole spacecraft. Both the predictable radiation levels of the Van Allen Belts and the short-term high-intensity radiation estimated to result from solar flares will have to be simulated because of the diversity of spacecraft employed by the center.

Also in the future is a need for a thermal environmental test capability, particularly for the launch phase. Thermal requirements, however, are as yet unclear, NASA scientists said. But, based on what is known now, the problem is unusually severe. For example, to simulate some launch conditions the chamber would have to be able to produce 1,200 kw (thermal) rapidly and then drop to below zero in about the same time span.

- **FY '64 requests**—Smallest of the newly requested test facilities is a remotely located hazardous test structure. At present, Goddard has no facility for testing any explosive or hazardous high-pressure system.

The new reinforced concrete building and storage bunker also will permit experiments on spacecraft systems such as radioactive sources, electro-magnetic radiation and tests involving use of high-pressure fluid or vapor systems.

A needed mechanical test facility will provide a means for evaluating dynamically the mechanical functions



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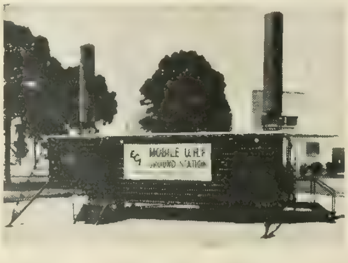

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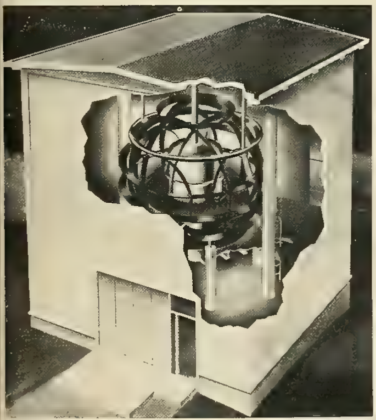
of spacecraft systems. The nearly $6-million facility will include a steel cylindrical vacuum chamber measuring 30 ft. high by 40 ft. in diameter. A high-performance pumping system will provide vacuum levels to within one micron.

The present payload test facility will be modified to handle up to 4,000-lb. spacecraft instead of the present 1,000 lbs. However, the principal addition will be an unusual solar simulator. It will be installed in the present 12-by-15-ft. thermal vacuum chamber.

Half the required $2.5 million needed will be used in the development of the new solar simulator, which according to NASA will provide a better spectro-match and a more uniform distribution than the large simulator (referenced earlier) in the big environmental test chamber.

- **Magnetic field facilities**—To measure the magnetic characteristics of spacecraft, flight systems, magnetometers, etc., Goddard is planning to build two unique test facilities. One will be a 20-ft.-dia. system which will be employed for the calibration of small payloads. The other will have a 40-ft.-dia. set of coils for use in testing attitude-control systems. Both will be able to produce a rotating field, and each system will employ three sets of four circular coils to produce a spherical enclosure.



ATTITUDE Control Facility uses 40-ft.-dia. Helmholtz coil assembly. (Artists conception.)

Each system will be temperature-self-compensating for variations over a 30-degree range and will be capable of normal operation in the temperature range of 65 to 90° F. Also, diurnal Earth magnetic variations will be sensed by a magnetometer for automatic correction (commutated, the monitor uses 3-4 ft. coils in series with the main coils which produce a current variation to null in the big coils).

Expected to cost about $585,000, the small coil facility is being built by Spectrophysics, Inc., and Arrowsmith Tool and Die Corp. It is scheduled to be installed and ready for operation by September, 1964.

Specifications for the system are unusually rigid: dimensional stability to 0.007 in./20 ft. (about 1/32 in.), and homogeneity to 0.001% throughout a 3-ft. center sphere. The latter is achieved by gradient cancelling.

The entire structure is being fabricated in a controlled environment of 70° ± 1° F. Also, a temperature-compensating turn will be employed on each coil.

The 40-ft.-dia. system will be used to map the magnetic field of complete spacecraft and check its magnetic moment. Also, by rotating the field it will be possible to measure the magnetic induced torque, GSFC scientists claim.

Goddard now has a conceptual design for the big Helmholtz facility and a detail-design contract is expected to be awarded within two months. Work is expected to begin on design develop-

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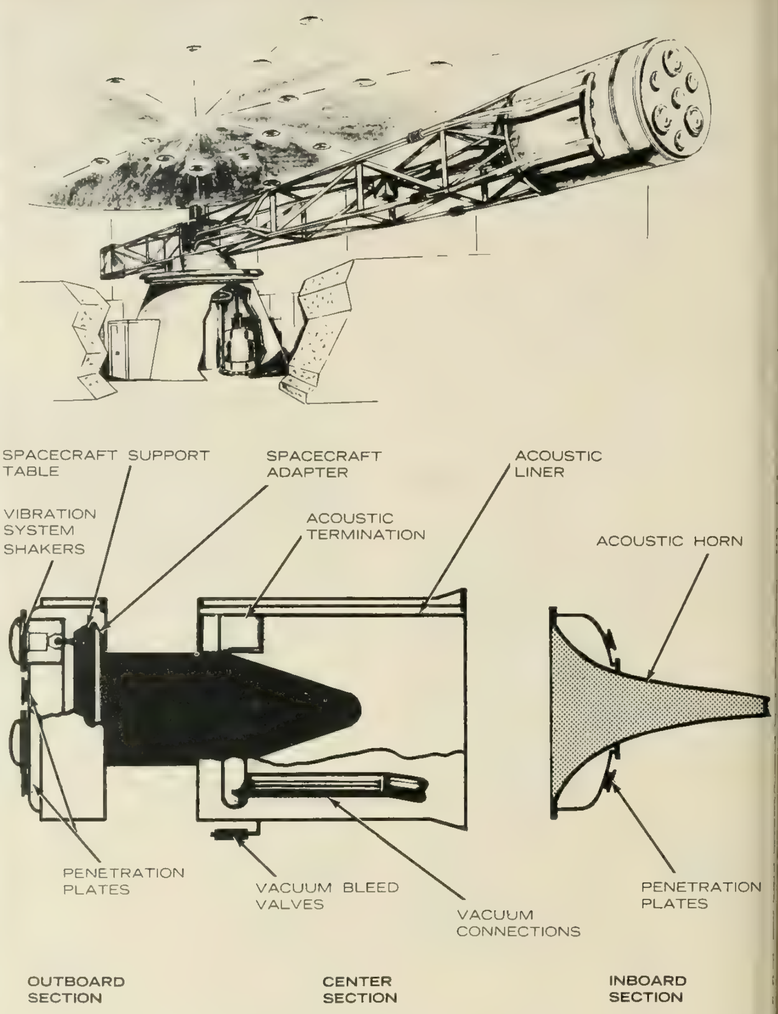
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TOP: Artist's conception of Goddard's planned Launch Phase Simulator. Centrifuge will have an effective arm radius of 60 ft., carry a spacecraft weighing up to two tons, and reach a sustained acceleration of 24 g's. It provides both mechanical vibration and acoustical effects. BOTTOM: Diagram of major functional parts of the Launch Phase Simulator chamber.

ment by March, 1964. Estimated cost will be of the order of $1.5 million.

Tolerances for the 40-ft. facility are approximately the same as for the smaller system; however, the homogeneity volume is a 6-ft. sphere to 0.001%. Input will be about 1,200 watts. Theoretically, the system will be able to measure spin damping torques to 100's of dyne-cm. sensitivity.

Each of the magnetic-field facilities will require about one year of test and calibration before it becomes operational.

- **Launch simulation**—Goddard's massive Launch Phase Simulator will in essence be a large centrifuge capable of producing up to 30 g's on a test vehicle of up to two tons in weight. It will handle a spacecraft measuring up to 10 ft. in dia. and up to 15 ft. long and is designed for OAO-class vehicles. As presently conceived, the test vehicle will be exposed to both mechanical and acoustical vibrations in real time, but not real-time accelerations.

The system was originally studied in-house by Goddard scientists and then under an $85,000 contract by Booz-Allen Applied Research, Inc., and Trident Engineering Co.

These initial studies were followed by an intensive aerodynamic study by the University of Maryland, using an

8-ft. model (1/20th scale). Besides solving the normal problems associated with atmospheric flight, it was found that the addition of a faired pit with a roof to the facility would considerably reduce the required horsepower from 13,300 to 5,500 hp input by reducing simple air resistance (in the enclosure, it was found that the air moved at about two-thirds the velocity of the centrifuge arm).

At the present time, Dynamic Devices, Inc., has been awarded a small contract to build a 1/20th-scale dynamic model. The new model is expected to be finished by January and tests will run for roughly 30 days.

Goddard is now evaluating proposals for construction of the Launch Phase Simulator. Although budgeted for about $4 million, the complete facility is expected to cost nearly $5 million.

Completion date for the system is August, 1965.

- **LPS design details**—The overall structure will be about 165 ft. in diameter and will have a 157-ft.-dia. pit. Center of the payload will be 60 ft. and the total rotating weight will be 464,500 lbs.

The design base calls for attainment of 23 g's sustained acceleration at 33.5 rpm with a capability of going to 30 g's at 38.3 rpm with additional drive motors.

Pressure within the test chamber will be reduced to 10^{-2} torr.

An integrated sound generator will cover the audio range from 100 to 12,000 cps and emit a maximum noise level of 150 db. Mechanical vibration will be applied over the frequency range of 5 to 100 cps with a thrust vector force of 20,000 lbs. (±4 g accel.) and a lateral translation of 10,000 lbs. (±2 g accel.).

Two 1,250-HP d-c motors will provide energy to drive the system, with a design capability to add two more later. Run-up time will be about five minutes. Regenerative braking will be employed, with mechanical braking beginning at 5 rpm.

Total rotating weight of the big LPS, including a 195,000-lb. counterweight, will be 464,500 lbs.

Design capacity of the 60-ft. rotating arm will allow up to a 5,000-lb. load at 10 g's (radial) and a 1,500-lb. load to 20 g's (radial).

The chamber vacuum system will match a launch profile varying from 760 torr to 1 torr in 130 seconds. It will employ a steam heat ejector having a 60,000-lb./hour steam consumption rate, plus a mechanical holding pump (100 cfm at 0.1 torr). ■

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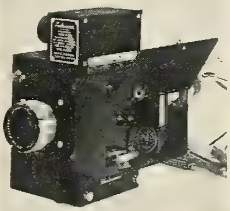


Langley Explores on the Ground While Hoping for Manned Space Lab

Lunar-landing research installation to be in operation shortly; hot-gas radiation facility, low-frequency noise laboratory in works

LANGLEY FIELD, VA.—Langley Research Center, paced by projects involving lunar landings, planetary re-entry and hypersonic speeds, is seeking a manned laboratory in space to furnish technical data unavailable from ground facilities.

The center at the same time is exploring new concepts in ground-based laboratories such as the hot-gas radiation facility which, together with a low-frequency noise laboratory, will soon be erected here.

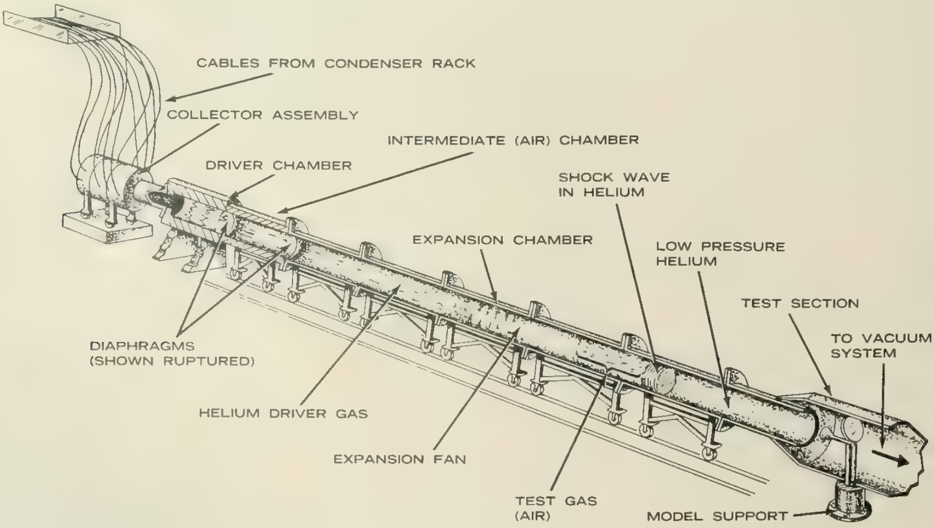
In giving space and money to a new facility, Langley officials try to be sure it will be useful in furnishing information on a broad spectrum of questions over a relatively long period of time. Thus, each investment must be based on the national program in aeronautics and space.

"We try to stay away from interim facilities," explained E. C. Draley, Langley assistant director. "We leave these for flight experiments such as Project Fire, where the effort is directed keenly to get a specific piece of information." This particular project is in the area of re-entry phenomena.

Langley engineers are delighted to describe additional facilities they would like to have a decade from now, but they freely admit they can look no further than a year or two ahead in knowing specifically what the center must have to carry out its missions.

"Don't get the wrong idea," warned C. J. Donlan, Langley associate director, "because we do know even now, in a generic sense, what new facilities we'll be needing—but not in a specific sense." And he added, "We try to conceive of techniques that will get us technical information as the space program expands . . . and we will need as many ground facilities and others as we can get."

Donlan stressed that Langley's facilities are put up in accord with NASA's broad program. This raises a question as to why Langley, instead of the Manned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PRELIMINARY sketch of Langley's hot-gas radiation facility for simulating re-entry after lunar mission.

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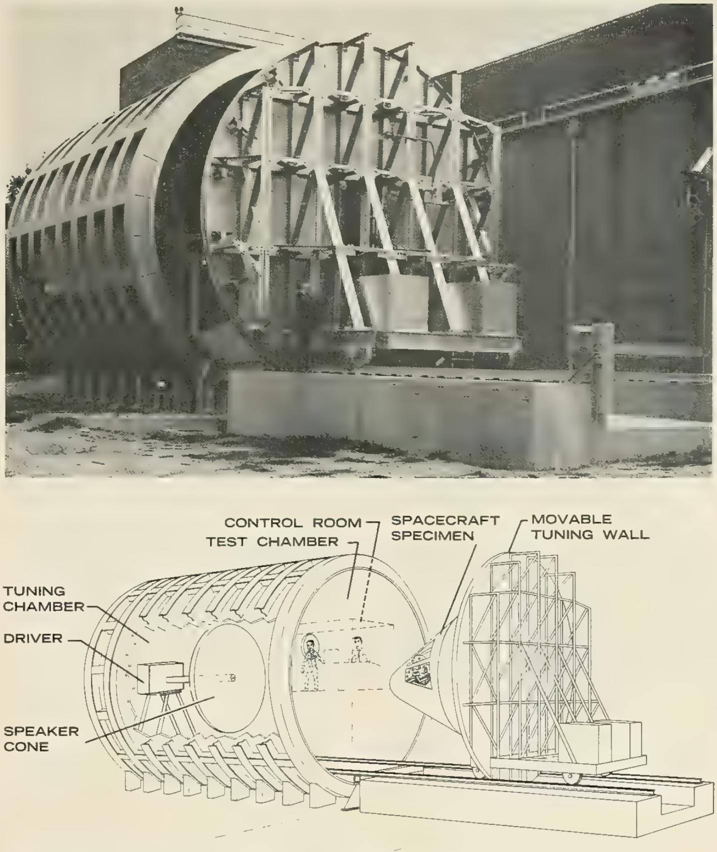

RECENT construction photo and sketch of low-frequency noise facility.

Spacecraft Center, is erecting a lunar-landing research facility.

This facility will be used by NASA scientists and test pilots to get basic information on handling problems and piloting techniques for all types of lunar-landing vehicles. Scheduled to be in operation late this year, the facility will be capable of handling a vehicle weighing up to 20,000 lbs. and will allow six degrees of freedom besides simulating the lesser lunar gravity.

Donlan pointed out that Langley's lunar facility was conceived two years ago, and was designed to feed technical data into the *Apollo* program. This type of research is an extension of the work Langley has traditionally conducted over a period of many years in connection with the study of stability, control and many other handling problems involved in landing and takeoff of vehicles designed to operate in the Earth's atmosphere.

"Even though the facility was not designed as a training device for lunar astronauts, it can be used to give data useful for such a purpose," Donlan explained.

● **Manned orbiter wanted**—Langley officials are pressing for a manned orbiting space laboratory that can be used in the same way as a ground laboratory. It would be an "extremely useful investment for the country in the next few years for both manned and unmanned space applications," said Donlan. Although such a laboratory is not an approved project, Donlan pointed out two of its advantages, perhaps in the expectation that some day it will have to be approved if the nation is to have a maturing space program:

—The manned orbiting laboratory is the only place where a zero-g environment can be maintained. Such an environment is needed, for instance, for designing and testing space stabilization systems whose performance may depend on gravity gradients so small they are masked by the "noise" in Earth laboratories.

—The space vacuum can be simulated nowhere on Earth, nor can the syndrome of radiation waves. Both of these can fundamentally affect the design of instruments and subsystems.

Langley officials insist that the space laboratory be manned, because "we cannot program unscheduled observations into a computer."

Continuing the theme, Draley said, "We're bound to need specialized test equipment and other devices for such an orbiting space station." Although he would not commit the center to encouraging the design of the equipment, he did observe that "the project is becoming more and more appealing as information is gathered from other sources. We could start working out some detailed space-station solutions now."

● **Prospective facilities**—Clearly the phenomena being studied dictate the kind of facilities needed. With this in mind, Draley called for experimental methods to study and control plasmas. Because Langley has a program of looking into plasma processes, "our feeling is this work will continue and new facilities will be needed," he said.

There is also an "appalling lack of information about the fatigue properties of metals at elevated temperature," said Draley. What is needed is a machine that will pull a vacuum and a temperature and include materials testing equipment. This is not necessarily a development project, but "will get increased attention," Draley affirmed, "especially when radiation factors are included, because they are bound to enter into materials questions."

Langley has no facility able to test hypersonic craft. "We even have to do research to find out what facilities would be adequate for the job," commented a Langley engineer. Mach 11.5-12 possibly represents the final development of the continuous-flow supersonic tunnel. When velocities beyond these speeds are needed for testing the craft, another means must be found to generate them, probably in some type of specialized tunnel without continuous flow.

Facilities do not exist to adequately test a high-speed ramjet engine, and it is still too early to tell what such a facility might look like. This would be in the Mach range from 4 to 16, 17 and 18.

Such a facility might be required to test a recoverable first-stage launch vehicle for an aerospace plane. Such a vehicle is already claiming the serious attention of many designers in Europe who feel that neither the United States nor Russia is showing sufficient interest in the concept.

Yet Langley is looking into the requirements for a high-speed engine-test facility, Draley told M/R. "We have the problem of designing inlets for high-

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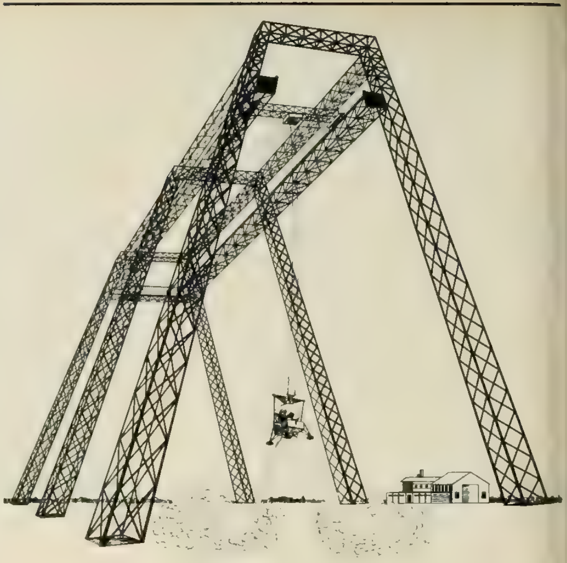

DRAWING OF lunar-landing research facility being erected at Langley to gain basic information on piloting problems.

speed jet engines," he said, "of studying shock phenomena and the means of generating flows to study these phenomena."

In electronics, there are requirements for new facilities, he observed, citing as an example the problems of antenna testing. "There's plenty of room for bright ideas in this area," he said, "and for advanced concepts, for instance, in the laser field and laser testing."

Facilities are also needed to simulate conditions of re-entry. There are shock tubes and guns, but in the main they lack the needed versatility. Flight programs, on the other hand, are expensive, undesirable from a security point of view and risky for personnel and equipment. The flight speeds of 35,000 to 40,000 fps called for would take an enormous powerplant in a ground facility. Yet the capability for generating such speeds is what Langley wants.

● **Facility yields 50,000 fps**—One answer is the hot-gas radiating facility (HGRF), now being built to reach flow rates up to 50,000 fps. It will not answer all the questions, but the flow patterns are of the right character. "We would like to have had the facility five years ago," said Donlan, "but nobody had the bright idea then."

HGRF was conceived by Robert Trimpi, Langley's head of the re-entry physics branch in the aerophysics division. In the Fiscal 1964 budget, Congress authorized \$2.62 million for the facility, which is scheduled to be operating in 1965. A pilot model has already been giving useful data.

The facility will be used to study radiation from any gases, including planetary gases from, for instance, Mars, Venus or Earth. It will duplicate the static temperatures and pressures found in the atmospheres. The difference between the HGRF and the shock tube is that in the latter the working fluid is at a relatively high temperature with the energy half in the form of kinetic and half in thermal. In the HGRF, about 99% of the energy of the working fluid is kinetic and only 1% thermal—a closer approximation of free-stream conditions.

In a typical test, Trimpi said, a spectrometer looking into the facility picks up the radiation from the hot-gas cap surrounding a model; this is the external view. Simultaneously, light pipes attached to the inside of the model give an internal view of the cap. Running time is in microseconds.

Instrumentation is being developed for the facility. "We haven't found any way to measure temperature yet," Trimpi told M/R, "although we are making progress on other factors." The temperature is in the range from 300 to 4,000°K; time response is about two microseconds. "This is not a facility requirement," he said, "but it would give us another bit of information about the free stream."

The HGRF is the subject of an in-house design study which is nearly completed. It will be constructed under a fabrication/installation-type contract.

The expansion tube is similar in many respects to a shock tunnel, but has a major difference in that the steady-flow varying-area nozzle expansion of the shock tunnel is replaced by a non-steady constant-area expansion.

Trimpi describes the apparatus as divided by two diaphragms into three sections. The driver or high-pressure section contains a gas at high pressure and high speed of sound. The driven section is filled with the gas in which the testing is to be performed. The expansion or accelerating section is filled with an accelerating light gas at very low pressure.

A diaphragm capable of withstanding high pressure separates the driver and driven sections; a weak low-pressure diaphragm separates the driven and expansion sections. The test section and model are located near the downstream end of the expansion section.

Details of the operation of the facility are given in NASA technical report R-133, "A preliminary theoretical study of the expansion tube, a new device for producing high-enthalpy short-duration hypersonic gas flows," by Robert Trimpi, 1962.

The most significant characteristic of the expansion tube, according to the report's author, is "it is the only fixed model facility known . . . which has the capability of duplicating the entire lunar-re-entry velocity-altitude environment with existing state-of-the-art technology."

- **Audio stresses**—Typical of the modern laboratories going up at Langley to help solve missile/space problems is the low-frequency noise facility. "We don't know much about noise in the sub-audible range—below 200 cps—and it could affect entire walls of buildings on a launch complex or launch vehicles as a whole, because the noise is in the range of the response frequency of those units," said Philip M. Edge, Jr., Langley aerospace engineer.

Edge pointed out that the facility will also be used for basic research purposes. Very little is known about the transmission of low-frequency noise, for example. Nor is much known about the effects of noise on people, the bioacoustic factor. Reference here is not only the response of the audio equipment, but also of body cavities.

The noise facility includes a speaker which is simply a 14-ft.-dia. plunger or piston able to move with an amplitude of 4.5 in. Worked either sinusoidally or at random frequency by an 18,000-lb.-thrust driver, the speaker cone is made entirely of aluminum sheet. The test chamber is 24 ft. in diameter, and provisions are included for changing the volume of the test chamber or for removing the end wall completely. Provision is also made for tuning the chambers behind the piston to balance some of the intertia loads of the piston.

The facility is being built under contract with McDonough Construction Co., Atlanta, and is expected to be operating early next year.

Langley is looking for new facilities able to solve classes of problems quickly, cheaply and accurately. Consider the *Apollo* problem. During re-entry, the capsule has a high heating rate lasting 15 minutes. Only about two to three minutes of the re-entry phenomena can be simulated. What is needed is a longer heating time and a higher heating rate, said Draley. Or maybe the problem can be solved in another way. Langley officials would be delighted to get another "expansion tube" idea. ■

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Ames Will Need New Magnetic Field Facilities to Fulfill Role

Center also likely to seek funds for hypervelocity plasma tunnel and wants to begin strong sounding rocket program of its own

MOFFETT FIELD, CALIF.—New magnetic field facilities will be required at the Ames Research Center because of its direction of the *Pioneer* and *Advanced Solar Probe* projects.

Ames officials report that no facilities exist capable of checking out magnetic-field equipment as sensitive as that on the two spacecraft.

As a result, the officials said, two or three new facilities will be needed at the center here.

The center also is expected—as part of its re-entry research program—to request funds for a prototype hypervelocity plasma tunnel. NASA headquarters turned down a request for the funds in the Fiscal 1964 budget, but Ames will probably repeat the request in FY '65.

The free-flight facility would enable data to be obtained at speeds of up to 50,000 ft./sec.

The common requirement for the magnetic-field facilities would be the capability of reducing ambient magnetic fields to less than one gamma. As the Earth's magnetic field fluctuates constantly by about 10 to 15 gammas and larger variations are a common occurrence in normal laboratory facilities, some sort of total nulling system that compensates for the field fluctuations would be necessary.

One facility would be needed for the magnetic testing of complete spacecraft of the *Pioneer* type, to insure that residual magnetic fields have been reduced to the minimum and to measure the effect of vibration-induced magnetization. Another, smaller facility would be required for screening proposed satellite parts for magnetic properties. It is, in fact, very difficult to get magnetically clean parts such as diodes and transistors for spacecraft applications.

The third facility would be used for long-term tests of sensitive magnetometers to examine their reliability. What is needed is the capability of testing an instrument continuously for periods of two to six months without extraneous magnetic disturbances.

There will also be need for theoretical and experimental studies to back up the probe project—both at Ames and under study contracts let by the center. Also, to continue its move toward direct control of space experiments, Ames would like to embark on a strong sounding rocket program.

The center is expanding its capability to investigate hypersonic flight. Studies are already in progress on hypersonic re-entry speeds typical of Mars return. If the go-ahead were given for a hypersonic air-breathing recoverable booster, a hypersonic cruise vehicle, or *Aerospace Plane*, there is no doubt that Ames would play a large part in the initial design studies in such a program.

Last year's budget amounted to approximately $40 million, including construction of facilities. A figure of about $50 million is proposed for this year.

- **Realignment**—Recent reorganization of the center reflects the concern with the development of refined tools for management and administration.

Previously the organization was facility-oriented; now it is organized on the basis of disciplines.

Two new asisstant directors have been appointed during the past year—one to look after the new projects, such as *Pioneer*, the other to look after advanced planning. There are now three assistant directors for departments with research functions; one has an operational function (managing projects), and the remainder have basically a support function—fiscal, and procurement, for example. These last two also have been reorganized.

Current work in the Mission-Analysis Division established last February is concerned with some 20 proposals for a period about three to five years in the future. A rough breakdown suggests that about 70% of future effort will be directed to space investigations, the remainder being aeronautical. However, the close links between hypersonic flight and re-entry problems tend to blur such distinctions.

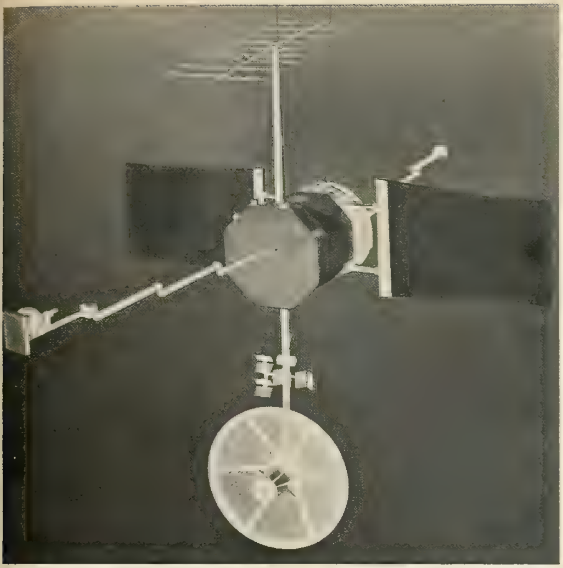
- **Project plans**—Ames does not intend to develop its own spacecraft, but does mean to have the capability to manage projects. In addition to the current *Pioneer*, *Biosatellite*, and *Solar Probe* projects, a sounding rocket program drawing some support from the universities looks attractive to the center. Advantages seen are the fact that the experimenter is close to the program, cost is low, and a large number of people is not required.

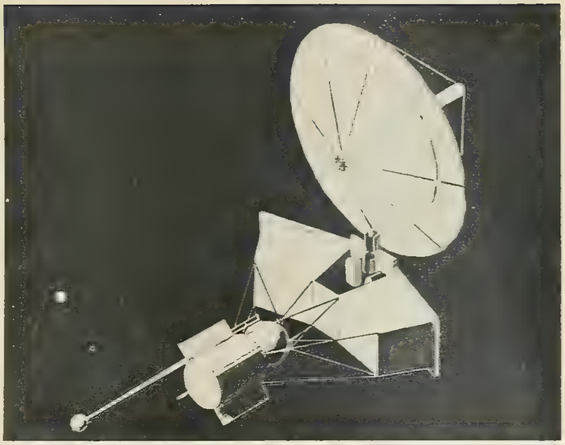
Ames has a number of experiments in its own immediate area of interest (space and planetary sciences) that it would like to carry out.

Launchings probably would be made from White Sands, N.M., and the center is interested in making measurements from instrument packages as they fall back through the ionosphere, as well as the more usual technique of taking measurements during the rocket ascent.

If such a rocket program were developed, the data analysis required probably would call for increased facilities, including a new data-reduction-and-analysis building.

For the *Biosatellite* project, General





ABOVE: Artist's conception of Advanced Pioneer being designed for Ames Research Center by Western Development Laboratories Division of Philco Corp. under $135,000 contract. LEFT: Heavy solar probe proposal by Honeywell. Ames has no plans to develop its own spacecraft, but will manage projects.

Electric Co.'s Missile & Space Div. is building six flight spacecraft plus ground-test models for the center, at an estimated cost of $19 million. From about 150 proposals some 50 experiments are being considered, four or five of which come from Ames. Experimental payloads accepted are likely to be announced in December; first flights are expected in 1965.

Four *Pioneer* satellites to investigate interplanetary space characteristics are being built for Ames by Space Technology Laboratories at a cost of $15 million, and Western Development Laboratories division of Philco is carrying out a $135,000 design study on the center's *Advanced Pioneer.*

Other contracts awarded by the center include studies of manned Mars missions, space biology, retrorocket parachute systems, and design for a plasma accelerator. A continuing procurement of study contracts of this nature can be expected.

- **Extraterrestrial life**—Youngest division in Life Sciences at Ames is the Exobiology Division. This has three branches: biochemical evolution, cellular biology, and life-detection systems. The first two are located in a 13,000-sq.-ft. building about one mile from Moffett Field.

Although it is the youngest division in life sciences, exobiology—the detection and study of extraterrestrial life—is at the core of NASA's space program.

Hitherto most of NASA's efforts have been concerned with getting into space and finding out how man can survive there. But once the means of getting into space have been achieved, the emphasis will turn to the ends, one of the most important of which is study of life on other planets. Consequently, projections out to 1975 show increasing activity in exobiology at Ames research.

This division contains about 40 to 50 people. It is very much a research laboratory operation and will continue to be so. Its main procurements therefore are likely to be laboratory buildings and laboratory instrumentation. Even the life-detection branch is research-oriented toward developing new concepts of life detection. If its investigations revealed the feasibility of a new method, it would put the production of hardware out to contract.

The Exobiology Division is presently putting together one of the best facilities in the country for the detection and analysis of organic compounds. Equipment includes a mass spectrometer, ultraviolet and infrared spectrophotometers, electrophoresis equipment, gas and paper chromatography equipment, an ultra-centrifuge, an amino acid analyser, and isotope-counting equipment.

The expansion of this division in the future certainly is not limited by equipment, but, as is continually the case, by ground space and staff. For example, there is a need to expand the life detection branch from the present seven people to about 30. There are openings for 13 scientists, but no floor space for them.

- **Biochemical evolution**—Oldest group in Exobiology is that concerned with biochemical evolution. Two main research programs are under way: study of the organic compounds that are synthesised under primitive Earth conditions, and study of the possible ways in which such compounds could play a part in the evolution of life.

The primitive Earth's atmosphere is usually thought to have been made up of some mixture of gases like ammonia, water, methane, carbon dioxide and hydrogen, but no oxygen. When energy such as ultraviolet light, electrical discharges, or heat is supplied to such an atmosphere, complex organic compounds that are the basis of life are formed, notably the amino-acid building blocks of proteins.

- **Jupiter experiments**—A pointer to future experiments is that conditions very similar to those of the primitive Earth exist now on Jupiter, and the creation of life may be in progress there. Consequently, the Exobiology Division is likely to have a considerable future interest in a planet that, at first sight, would seem to be very hostile to life.

- **Martian simulation**—Currently, much of the interest in the Exobiology Division centers on Mars. Experiments are under way to discover more about the physical conditions that can exist on its surface and also to find out if Earth organisms—various types of bacteria—can exist there.

Much of the work involves the use of simulators that duplicate Martian radiation, temperature, and atmospheric conditions. Simulators currently in use have a capacity of about two cubic feet. Somewhat larger simulators will be needed, with the capability of allowing insertion and withdrawal of samples without disturbance of the simulated conditions.

Ames experiments show that bacteria can survive the temperature extremes of Mars and flourish, provided they have water. Positive identification of water in the pole caps of Mars has therefore been most meaningful.

Studies are being pursued to find out what sort of concentrating mechanisms might exist to provide sources of water for bacteria. The possibility of a permafrost layer on Mars has been shown in a simulator at Ames. This means that local geothermal activity on Mars might provide small oases.

Alternatively, the water might be locked up in salt deposits. Experiments at Ames have shown that some bacteria can extract water from salt deposits quite easily. Bacteria of this type are available in the nearby salt evaporators on San Francisco Bay. The next step is to find out whether these bacteria can also survive the physical and atmospheric conditions on Mars.

Other experiments will examine what types of bacteria can exist under very dry conditions and what effects Martian conditions have on molecules such as DNA.

Studies such as these will play a large part in firming up specifications for sterilization of planetary probes. Concurrent with this work there is also a program to identify all organic compounds that will be carried aboard future planetary probes.

Ultimately, the division's interest in Martian conditions will lead to experimental probes to examine the surface of Mars and to perform life detection experiments.

- **Environmental biology**—Biological changes that result from space environments are studied by the Environmental Biology Division. Investigations are being made at four levels—to detect changes in body chemistry, morphology, physiology, and behavior.

The division is studying how animals and man adapt to changes in the space environment, the limits of tolerance to such changes, and means of extending the limits.

Currently most of the behavior experiments use apes as subjects, but really good behavioral experiments will have to await the availability of a manned orbiting laboratory. Ames would expect to have the direction of those space station experiments concerned with biology and the study of man, and a biologist-physician would be needed as a crew member and experimenter.

The behavioral differences between man and ape are very great, and there is a strong need for the type of experiments that an orbiting space station would permit.

- **Gravity adaption**—In its attempt to find out the biological adaption that takes place under prolonged zero-g, the division is subjecting rats to prolonged periods of about 4-g. The aim is to return a high-g-adapted rat to normal g and discover the type of reverse adaption that takes place. It's hoped that the types of adaption will indicate changes that occur when an animal goes from Earth gravity to zero-g.

So far, the studies have been concentrated on chemical changes attributable to adaption to increased gravity, but some effects have also been noticed in the nervous system.

Changes in nervous system are fairly rapid, while the chemical changes occur over a much longer period. Centrifuge experiments have shown that there are specific and predictable changes in energy metabolism as a result of increased g. Among the changes noted are increases in blood sugar, blood fat, and liver glycogen, and a rise in the ability of liver slices to synthesize protein.

- **Radiation facility lacking**—One hazard of the space environment—nuclear radiation—poses considerable experimental difficulties for the Environmental Biology Division. Most high-energy particle generators produce only a narrow beam of radiation that is of no use, for example, in completely irradiating an ape. Biological research is being seriously hampered by lack of suitable radiation facilities.

Most radiation work is done by the Atomic Energy Commission, and development of a biological radiation facility at Ames may be undesirable owing to the center's lack of both ground space

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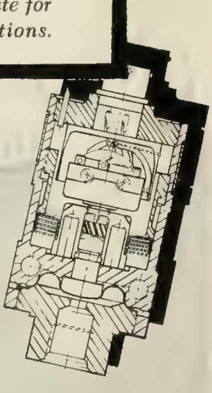

and experience in operating such a facility. This is, however, an important branch of environmental biology; some form of close association between Ames and a radiation facility that can provide biological data will be necessary.

- **Biological instrumentation**—The need to study body chemistry, and particularly the requirement to measure very small concentrations of chemical substances in the blood stream, is leading to the development of new detection methods at Ames. For example, for detecting very small concentrations of pituitary substances in the blood stream, a method of 1,000 times more sensitive than current methods has been developed.
- **Astronaut's heart**—The division also is studying the effect space-vehicle interior conditions—high temperature, lack of oxygen, and high acidity—will have on the power of the heart. If these variables go far outside their normal range, the heart's power diminishes. Studies in progress will see how predicted cabin conditions affect an astronaut's heart, and whether plant alkaloids can increase the heart's ability to resist these changes.

Since the Environmental Biology Division is concerned with the basic question of man's chances of long-term survival in space, its chief effort will be over the next ten years—first to examine the problems posed by the *Apollo* and *Manned Space Laboratory* projects, and then to monitor the effect of space environment stress, provided no unforeseen major biological problems appear. Towards the end of this period the emphasis in the space program will turn increasingly to exobiology.

- **Space sciences**—The Space Sciences Division has expanded considerably in the past year and is likely to continue to do so in the future. There are enough problems to occupy the division well past 1975.

At present the division has a laboratory with about 10,000 sq. ft. of floor space and is considering bids for conversion of 6,000 sq. ft. of a hangar into a laboratory facility.

The division has three branches: Planetary sciences, electrodynamics and theoretical studies.

Planetary sciences is divided into planetology, and atmosphere and astrophysics studies. In planetology, hypervelocity cratering and erosive processes on atmosphere-free bodies such as the Moon are under investigation.

- **Luster**—By extrapolation of light-gas gun work to higher velocities, research workers have shown that the amount of material blasted out of the Moon by a meteorite impact exceeds that in the meteorite, so that depletion of the Moon occurs.

The aim of the proposed research program *Luster* is to use a sounding rocket to collect lunar debris of this type trapped in Earth's orbit. Identification of lunar material would depend on low-level radiation-counting techniques to detect aluminum-26, which might reasonably be expected to be contained below the Moon's surface.

- **Low-level counters**—Suitable low-level counting equipment now being developed at Ames would have a wider application than simply for *Luster*. Many instruments of this type are needed for general field use in meteorite studies; there, also, the presence of aluminum-26 would be an indication of extraterrestrial origin.

Materials collected by the sounding rocket would be analyzed by an electron microprobe, for which an ultra-clean room will be required. In addition, a white room for sterilization of the sounding rocket system will be needed, as the material collected in space will be examined for organic materials and evidence of living organisms.

Another application foreseen for sounding rockets by the Space Sciences Division is in the study of planetary atmospheres by detection of radiation that is normally absorbed or obscured by the Earth's atmosphere. Nitrogen

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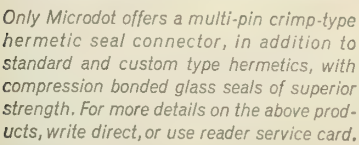

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emission lines, for example, have not been observed from any planet, although its existence has been inferred.

For scanning planetary atmospheres, the instruments in the sounding rocket will require pointing to an accuracy within 10 seconds of arc. Work on this problem is under way at Goddard Space Flight Research Center, which is developing an intertial attitude sensor and star tracker for fine pointing of an *Aerobee*.

- **Spin-flip hydrogen**—Another sounding rocket experiment under consideration at Ames is measurement of the spin-flip transition of molecular hydrogen in space. Certain molecular emission bands should be detectable and provide a means of calculating the relative density of the aligned and unaligned states. In this way an indication of the production and decay rates of unaligned-spin hydrogen could be obtained.

Ames is also trying to get approval for an infrared orbiting observation to study the telluric lines in the Martian atmosphere. This project is currently waiting for approval by NASA Headquarters. Initially, the Space Sciences Division is asking for sufficient R&D funding to make a start with experimental commitment in one of the later *Orbiting Astronomical Observatories*. This would be an Ames experiment on a Goddard *OAO* project.

- **Dust bombardment**—Studies of dust are being conducted in Ames' space sciences laboratory, where a vertical gas gun is being built to simulate possible grinding processes on the Moon's surface.

The gun will fire down into dust held on a platform. At the time of firing, the platform will be accelerated away from the gun at a rate that subjects the dust on the platform to an equivalent gravity of one-sixth g. In this way lunar gravity conditions are simulated at the time of impact of the dust particle, and it should be possible to see what type of grinding has been going on for the past ten million years. It should also be possible to simulate solar wind and to determine whether this has an erosive effect.

- **Micrometeorite gun**—Also under development is a micrometeorite gun that should provide dust velocities of 40 km/sec. Diamond dust is suspended in a quadrupole rf field and an ion beam is fired at one isolated particle, developing an extremely high charge-mass ratio on it. The charged dust particle, about one micron or less in diameter, is then accelerated by means of an electric field. This gun will be used to study erosion mechanisms and micrometeorite damage.

- **Free-radical chemistry**—Studies on space chemistry now starting in the Space Sciences Division are mainly concerned with free-radical chemistry that might be expected to apply to icy materials in free space and possibly on the giant planets. At present, the division has no chemical laboratory; this will be a requirement if preliminary studies show that free-radical chemistry is of significance in NASA's program.

Jupiter may contain stable free-radical species. Both the Space Sciences Division and the Exobiology Division are likely to develop an increasing interest in this planet as planetary probe capabilities improve. Later this interest will probably extend to the more distant planets.

- **Planetary atmospheres**—Studies at Ames have shown that measurements of the aerodynamic and thermal effects experienced by probes as they enter planetary atmospheres can be used to discover the structure of the gas mixture around the planet. Because of the absence of planetary data of this sort, Ames is interested in promoting an early experiment in which data are telemetered back by a probe entering a planetary atmosphere.

- **Plasma studies**—Experiments by the electrodynamics branch of the Space Sciences Division are chiefly concerned with plasma probe measurements, but mass spectrometers and magnetometers are also used. The branch has plasma probes on *Explorer 14*, *EGO*, *IMP's A*, *B*, and *C*, and tentatively on *Pioneer*. Like many other research groups, the branch is looking at future experiments on cosmic rays.

Closer to Earth, the electrodynamics branch is also interested in the morphology of the ionosphere in terms of electron density. Analysis of data obtained from the *Alouette* topsounder experiment might become a future joint propect between Ames and the Central Radio Propagation Laboratory, Boulder, Colo.

In addition, a sounding-rocket program to analyze the ionosphere might be initiated. This could take the form of an instrument package taking measurements as it fell back to Earth, rather than taking measurements during the upward rocket flight. Retardation of the package by a "ballute" is one of the possibilities being looked at.

- **Vacuum deterioration**—One problem that has turned up recently in this connection is depletion of ablative materials under hard vacuum. An ablative heat shield that works well in an arc-heated furnace can deteriorate considerably in a hard vacuum. After some time at a pressure of 10^{-8} torr, about half of an ablative heat shield can disappear. If ultraviolet radiation is present—as it would be in space—the effect is much worse.

To study these effects and related

problems, a Space Materials Laboratory has been proposed in the 1964 budget.

The proposed facility would give a capability to study the effect of a number of simultaneous variables. As well as high vacuum, electro-magnetic and nuclear-particle radiation, impact by micrometeoroids and the heat sink of outer space would be simulated.

Total cost of the facility would be $3.6 million. The vacuum chambers would include a 5-ft.-dia. chamber for pressures down to 10^{-10} mm Hg. and a 16-in. bell jar for pressures down to 10^{-15} mm Hg. Each would be equipped with cold-wall panels that can be cooled with liquid nitrogen or helium.

Solar-radiation simulators consisting of filtered sources producing fluxes of up to 13,000 watts per sq. ft. would be installed. Particle radiation would be provided by 1 kev to 1 mev ion accelerators. To simulate micrometeoriods, particles of submicron size would be accelerated to over 30,000 feet per sec. electrostatically.

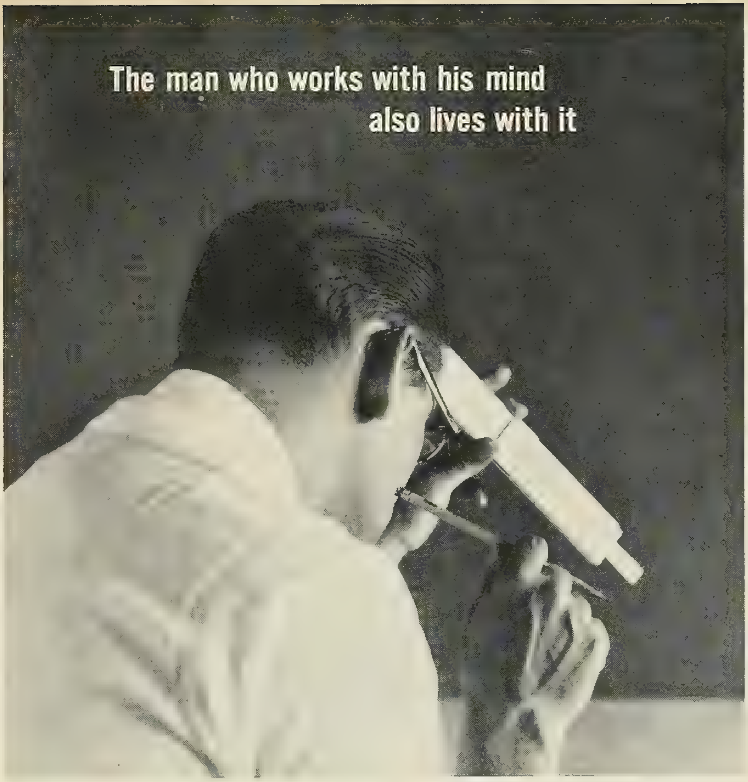
Research instrumentation will include mechanical test equipment, vacuum furnaces, X-ray diffraction equipment, polymer synthesis and characterization equipment, mass spectrometer, and data-recording instrumentation.

- **Satellite attitude control**—Work on satellite attitude control is increasing at Ames, because of the center's acquisition of satellite projects. To evaluate the performance of systems for space vehicles the center has proposed a $1,230,000 test facility with a spherical vacuum chamber of about 140-in. diameter. Control systems will be mounted on a platform supported on a gas bearing within the chamber. Attitude references such as the Sun, Earth and stars will be simulated on the walls of the chamber.

The platform will be about 90 in. in diameter and have its own control system for initial alignment, and its own power supply.

- **Structural dynamics laboratory**—To provide a central location for structural dynamics research and for the pretest calibration and checkout of models involved in dynamic tests, Ames has proposed a new $1,644,000 facility. This would include vibration shakers and heat sources (4,000°F surface temperature), to be used in combination.

- **Spaceflight simulator**—A contract for a facility to simulate the environment, accelerations, motions and tasks for crew and equipment in a representative three-man space capsule during take-off, midcourse flight, reentry and landing has been placed with Genisco. The facility is currently in the drawing stage and is basically an advanced pilot-controlled centrifuge. It should be in operation by 1965. ■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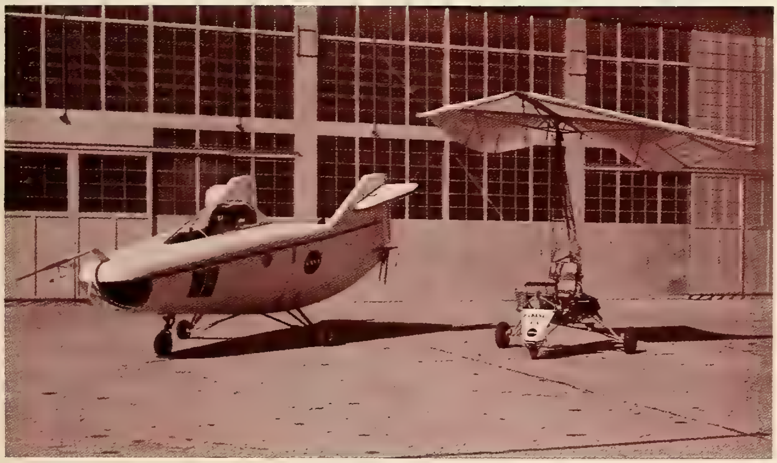
Flight Research Center Seeking Hypersonic Craft For ASP Work



TWO UNIQUE vehicles being flight-tested at FRC. Left, M-2 prototype of future winged spacecraft. Right, Parasev, used to evaluate a flexible wing as recovery device.

Marquardt report on modifying X-15 to carry ramjets is due in January; FRC also studying $1-million air-launched lifting-body configuration, planning to update radar range, probably will ask $2.9 million for new laboratory

EDWARDS AFB, CALIF.—NASA's Flight Research Center here would like to build a hypersonic research airplane at a cost of $500 million in an effort to provide the research leading to development of an aerospace plane.

The hypersonic plane would require the development of a 60,000-lb-thrust ramjet engine. Four of the engines would be used to power the booster to speeds of Mach 8 and Mach 9. The plane could be flying by 1967, FRC officials say.

A contract with Marquardt Corp. to study how the *X-15* could be modified to carry two ramjets that would be used for hypersonic air-breathing research will be completed in January. The center plans to develop, build and test critical components of the propulsion system by the third quarter of next year.

Other new developments at the center:

- Studies are under way for a lifting-body configuration that will be air-launched and have a man-rated throttleable rocket engine capable of sending it to speeds of Mach 2. It will cost about $1 million.
- The center plans to update its current three-station radar range into a single high-precision station.
- The center probably will request $2.9 million in Fiscal '65 for a Flight Research Laboratory.

At present about 15% of the Flight Research Center's effort is in direct support of the space program. Approximately 30% has a secondary relationship to the space program.

Currently its budget is running at about $20 million per year.

As the Flight Research Center's future depends on its having new aircraft to flight-test, its program is closely tied to national decisions on future aircraft requirements.

The present growing workload on the *X-15* shows that it can continue to provide valuable flight data out to 1967 or 1969.

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DISCIPLINARY RESEARCH UNDER CONSIDERATION AT THE FLIGHT RESEARCH CENTER

DISCIPLINARY RESEARCH	AIRCRAFT	GROUND FACILITIES	CALENDAR YEAR 1963	1964	1965	1966	1967	1968
Space science	X-15		—	—	—	—	—	—
Aircraft handling qualities	X-15	1, 3, 4, 7, 8	—	—	—			
	Executive transport	1, 3, 4, 7, 8	x—	—	—	—	—	—
	Light plane	1, 3, 4, 7, 8	x—	—	—	—	—	—
Flight display research	X-15	1, 6, 8	—	—	—	—	—	—
	F-104		—	—	—	—	—	—
	JetStar		—	—x—	—	—	—	—
Biotechnology	X-15	1, 6	—	—	—	—	—	—
	F-104		—	—	—	—	—	—
	F-100C		—	—	—	—	—	—
Control system research	X-15	1, 4, 6, 8	—	—	—	—	—	—
	F-100C	1, 4, 6, 8	—	—	—	—	—	—
	JetStar	1, 4, 6, 8	—	—x—	—x—	—	—	—
Electronic system research	F-104	1, 6	—	—	—	—	—	—
Environmental research	X-15		—	—	—	—	—	—
	F-104		—	—	—	—		
	XB-70			—	—	—	—	—
Hypersonic aerodynamics	X-15	1, 2, 3, 4, 5, 7, 8	—	—	—	—	—	— —
	X-20	1, 2, 3, 4, 5, 7, 8	- - -	- - -	- - -	- - - x	- - -	- - -
	HRAC	1, 2, 3, 4, 5, 7, 8		- - -	- - -	- - -	- - - x	- - -
Hypersonic propulsion	X-15	4, 5, 6, 7, 8	—	—	—	—	—	—
	HRAC	4, 5, 6, 7, 8	- - -	- - -	- - -	- - -	- - -	- - -
Structures flight research	X-15	1, 2, 4, 5, 7	—	—	—	—	—	—
	F-104	1, 2, 4, 5, 7	—	—	—	—	—	—
	X-20	1, 2, 4, 5, 7			- - -	- - -	- - -	- - -
	HRAC	1, 2, 4, 5, 7				- - -	- - - x	- - -

Ground facilities are detailed below.

GROUND FACILITIES FOR SUPPORTING FLIGHT RESEARCH

GROUND FACILITIES	CALENDAR YEAR 1963	1964	1965	1966	1967	1968
1. Static simulators	—	—	—	—	—	—
2. Calibration lab	—	—	—	—	—	—
3. Radar range	—	—	—	—		
4. IBM 704	—	—	—	—	—	—
5. High-temperature facility	- -	- - -	x - - -	- - -	- - -	- - -
6. Flight support lab	- -	- - -	- - x - -	- - -	- - -	- - -
7. Radar range updating		- - -	- - -	x - - -	- - -	- - -
8. General purpose visual simulator			—	—x—	—	—

Solid line indicates time in service.
Dashed line indicates proposed or under consideration.
x indicates flight or operational date.

• **Booster potential**—But the big boost for the FRC research through the 1970's would come if tests over the next few months show the practicability of hypersonic ram jets for the first stage of recoverable boosters.

Favorable test results would pave the way for a hypersonic research aircraft that would become a flying wind-tunnel for hypersonic air-breathing engine development. Studies at the Center show that this probably would be a cheaper way of developing hypersonic engines than building a hypersonic wind tunnel on the ground.

The go-ahead for a supersonic program would depend on a national program for an air-breathing hypersonic transport, hypersonic cruise vehicle, or hypersonic first stage for *Aerospace Plane*. Present indications are that these projects are economically attractive, provided a hypersonic air-breathing engine can be developed.

The real requirement at present is for a Mach 8 first-stage vehicle that can not only boost a second stage into orbit but also land and take off like a normal aircraft. There is a somewhat lesser requirement for a hypersonic cruise vehicle.

FRC has let a study contract on how the *X-15* might be used for hypersonic air-breathing engine research. It expects the contract to be completed by next January.

The center plans to develop certain critical components of the propulsion system and have them built and tested by the third quarter of 1964. At this time a decision would be made on whether an air-breathing propulsion system (burning liquid hydrogen) should be constructed for attachment to the No. 2 *X-15*, currently being rebuilt with this modification in view.

Work at the Lewis Research Center in the late '40's showed that it would be a relatively simple matter to convert a jet to hydrogen burning.

A go-ahead would call for joint Air Force/NASA funding in 1965 for the engine and its installation.

- **Mach 8 X-15**—This line of development is very much tied to the rebuilding of the No. 2 *X-15*, which is expected to fly at speeds up to Mach 8. Following the damage incurred by this aircraft, time and cost estimates for obtaining the added performance in comparison with those for straight repair turned out to be very attractive.

The modified aircraft will have an extension in its fuselage that can house instrumentation or a liquid hydrogen supply. Modifications will also enable extended landing gear that will accommodate the largest-size engine under the aircraft.

The initial phase of the program will involve subsonic-burning ramjets to be tested in the range from Mach 4 to Mach 6. Later, supersonic burning would be investigated up to the Mach 8 performance limit of the aircraft.

Various flight surfaces will have coatings to protect the Iconel structure from the heating rates to be expected at Mach 8. An ablative-type material probably will be used. Tests on suitable materials are under way in the present *X-15* program.

Valuable as this hypersonic program will be, the engine flights at Mach 8 speeds will be of brief duration and the aircraft will continue to be air-launched. Also, the propulsion units will necessarily be smaller than those required for hypersonic missions.

For the hypersonic projects mentioned, an engine capable of flying an aircraft at Mach 8 to 10 is needed, and the aircraft must be capable of taking off from the ground and flying through all the normal flight regimes.

This raises a number of problems that cannot be adequately dealt with by the extended *X-15* program, and FRC has been considering how effort on these problems might be focused into a coherent research program.

The most attractive solution seems to be a departure from the center's usual policy of testing pure research craft—turning to a research aircraft with a direct mission application.

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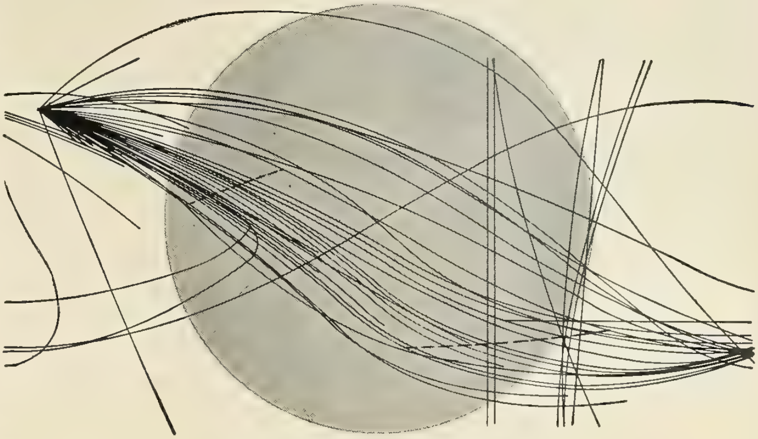

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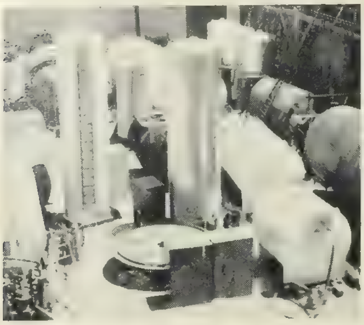

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There currently is no facility for testing engines for Mach 8 aircraft. If such a facility was funded it would only be capable of running tests with a duration of a short number of minutes. To achieve 100 hours running time on a hypersonic engine in such a facility would call for several years of testing, says FRC.

- **New aircraft possible**—The alternative suggested by FRC is to develop a hypersonic aircraft to test an engine directly over extended periods and to use the engine in multiples for a hypersonic booster. Because such a research aircraft would cost many times as much as the *X-15*, it would be made as small as possible.

The idea would be to develop an engine with about 60,000 lbs. of thrust for this experimental plane, and to use four of the engines in a hypersonic booster.

The test aircraft would have a lightweight structure and sufficient volume for adequate liquid hydrogen storage for missions about five times as long as those of the *X-15*. The volume requirements would be tied in with the requirements of a lift/drag ratio suitable for operation out of Edwards AFB.

The configuration that meets these requirements is a vehicle weighing 80-90,000 lbs. and having a slim delta wing. It could take off from the ground at a speed of 200-230 knots and operate at altitudes up to 150,000 ft. It would also land under power. With the proposed 60,000 lbs. of thrust, speeds of Mach 8-9 would be reached.

Based on previous experience of predictions for the *X-15*, FRC thinks that these figures are likely to be accurate to within about 10%. The aircraft could be flying by 1967.

- **X-15 till 1967-9**—Soon after the first-flights of the *X-15*, a flood of suggestions for new experiments came into FRC. Many have been brought into the research program, and the work load for the *X-15* next year is heavier than for the current year. About 60% of the original objectives have probably been gained by now.

One section of the future program is concerned with space sciences and stems from the capability the *X-15* provides for observing phenomena at high altitudes. There are about 18 of these studies, for which the *X-15* provides a highly stable platform. This capability arises because there are two stabilizing systems present—one correcting aircraft attitude, the second being a stabilized instrument platform in the aircraft.

Typical studies that will be carried out are ultraviolet stellar photography, evaluation of horizon-sensing stabilizing systems, measurements of Earth backscatter of infrared and ultraviolet radiation, measurement of the radiation environment inside and outside the *X-15*, and studies of systems under zero-g conditions.

- **Lifting bodies**—Following the successful flight of the *M-2*, preliminary design studies are under way at the Center for a lifting-body configuration that will be air-launched (like the *X-15*) and will have man-rated throttleable rocket engines capable of sending it up to Mach 2. It will use flight contro systems and other available airplan equipment that is already developed The program would probably cost abou $1 million.

The lifting body looks quite feasibl for subsonic and hypersonic speeds, bu some of the data for transonic speed do not look so good. Unfortunately, th transonic region for fat bodies of thi type extends from about Mach 0.7 to Mach 1.5.

- **Parawing**—Because of its experience gained with the Parasev vehicle and the considerable amount of research and operational knowledge tha remains to be obtained before th *Gemini* can be definitely committed t a paraglider landing, FRC has gaine technical responsibility for the paraglider program. This will involve a flight research program on two unmanned and two manned *Gemini* paragliders, extending through 1964.

- **Lunar landing simulator**—A vehicle that simulates the general configuration of the proposed lunar landing vehicle is being constructed for the center by Bell Aerospace Systems, using a propulsion system supplied by Genera Electric. First flights of the vehicle ar planned for June, 1964.

Main aims of the program are t investigate pilot visibility and presentation, pilot control systems, flight and touchdown dynamics, and crew functions and positions.

Two vehicles have been ordered After about six months of the fligh program, one will be modified to include an improved jet engine and rocke engines identical to those of the *Apoll* Lunar Excursion Module.

As the vehicles simulate lunar conditions, aerodynamic characteristics ar cancelled out. This means that the vehicle could also be used for studies o VTOL aircraft control system characteristics. Hitherto, studies of VTOL aircraft have yielded data on the combined effects of aerodynamics an thrust vectoring, and the ability to cance out the aerodynamic effects could provide new insight in the VTOL contr systems.

Addition of variable-stability equipment will allow the vehicle to be converted to a variable-stability aircraft fo research on V/STOL aircraft.

- **Radar range updating**—The existing three-station radar range was built in 1956 to support the *X-15* program, by modifying World War II-type radar. It provides coverage over a distance of about 600 mi. Wear is decreasing its accuracy, and performance is now marginal. Future programs, including evaluation of the B-70, will require precision beyond the range's capability when it was new.

Therefore, FRC proposes in 1965 to replace the present three-station radar range with a single high-precision station.

- **Flight research laboratory**—Over the past four years the center has been developing ground simulation of aircraft systems, pilot displays, and biomedical and human factors systems to support the high-speed flight research program. The point has now been reached where the personnel and equipment for a flight-research support laboratory exists, but they are located in various temporary and unrelated hangar and shop areas, normally used for aircraft maintenance and offices. To provide better housing and coordination of these activities a new $2,924,000 laboratory has been planned and funding may be requested in Fiscal '65.

- **High-temperature facility**—To supply the loads and heating for simulation of the flight environment of high-performance vehicles operating within the Earth's atmosphere, a high-temperature-loads calibration facility has been proposed.

When FRC was constructed, a structural loads calibration laboratory was installed. However, because the potential usefulness of the *X-15* has turned out to be considerably greater than was anticipated, the present loads calibration facility has become inadequate.

In particular, FRC is concerned about its inability to analyze structural heating results properly.

For example, the permanent structural deformations and localized failures occurring during the *X-15* program can provide excellent end-point conclusions for structural design, if the causes of these occurrences are analyzed. But such analysis can only be developed if a ground facility is available to provide experimental validation.

Although the *X-15* is instrumented to determine the structural stresses and loads during its flight at elevated temperatures, full use of the measurements has not been made because of lack of ground facilities to calibrate the airplane and instruments at elevated temperature.

The $1.1-million high-temperature loads laboratory would handle components of large vehicles or complete aircraft of the size of the *X-15*. Work on the laboratory will begin in fiscal 1964. ■

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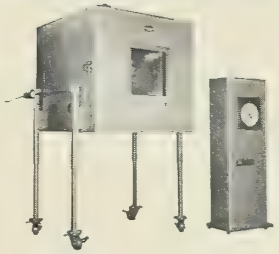

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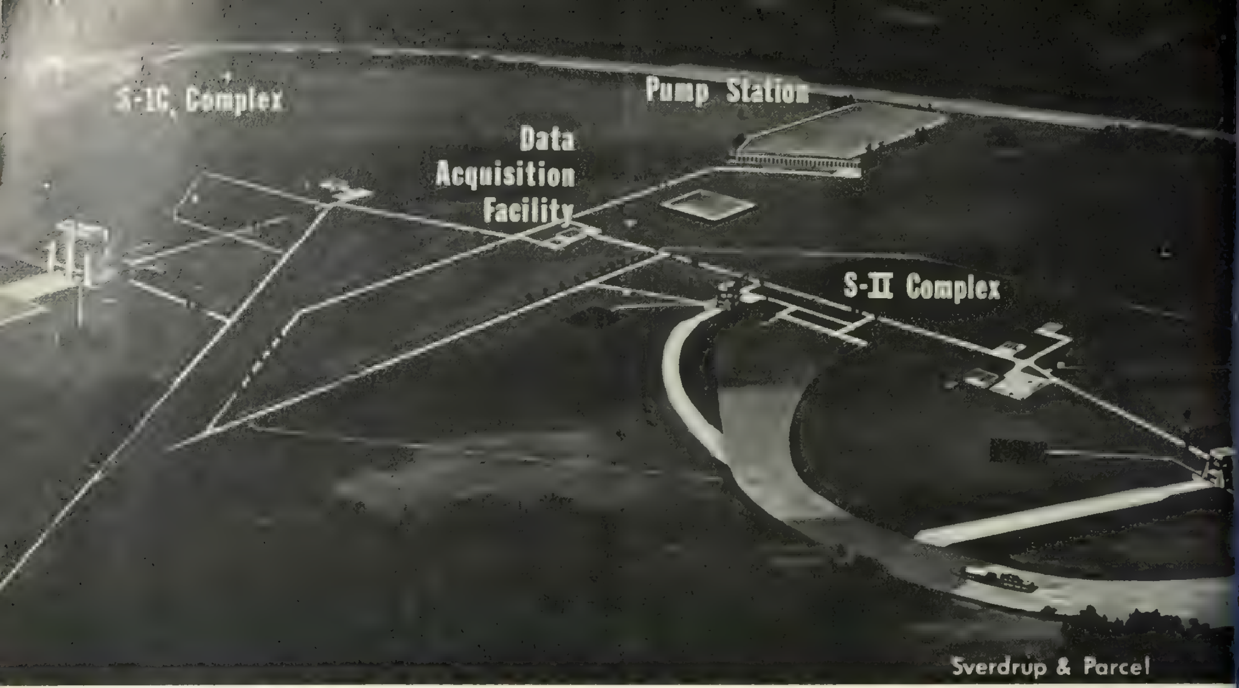

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VIEW OF CONSTRUCTION for Advanced Saturn Complex at Mississippi Test Operations.

Mississippi Test Operations Spending To Hit Peak in Fiscal 1965

Drop-off expected after $176.7 million more is invested in tes facilities for Saturn V stages; site preparation proceeds apace

PICAYUNE, MISS.—A sharp drop in spending is foreseen for Marshall Space Flight Center's Mississippi Test Operations after its Fiscal 1965 funds are committed.

Capt. William C. Fortune, the test facility manager, estimates annual operating expenses will range between $20 and $30 million after another $176.7 million is spent to complete facilities needed to test S-IC and S-II stages of *Saturn V* before they are shipped to Cape Canaveral for launching.

The test facility's Fiscal '64 budget request was $111.7 million, and Marshall fiscal people had planned to request an additional $65 million in Fiscal '65 to complete facilities for testing *Saturn V*.

But Congressional committees recommended sizeable cuts in the current request, giving rise to speculation that MSFC may have to increase its budget request next year for the Mississippi operation in order to have the test center ready by the time *Saturn V* stages start arriving in mid-1965.

- **Genesis**—Center spending started in the autumn of 1961, when the U.S. Army Corps of Engineers began purchasing land needed for the center. The Fiscal '62 budget included $18.5 million, of which $16 million went to land acquisition and $2.5 million to design of facilities.

The land purchased was 128,00 acres of South Mississippi pine fores on the banks of the East Pearl River, navigable stream providing easy acces to the Intracoastal Waterway which connects Cape Canaveral with the Michoud *Saturn* manufacturing plant in New Orleans.

Designers of the facility concentrated all testing and support activities in a 13,500-acre tract in the center o the acquisition, leaving the surrounding area to serve as an acoustical buffer

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zone. The planners, looking to the future, laid out the peripheral canal system so it can be extended to additional test sites when needed.

In the following year, MSFC budgeted $73 million for the Mississippi Test Operation but added another $5.8 million in the later summer of 1963 from Fiscal '63 funds to assure completion of the S-II test stands on schedule.

- **Building progress**—This fall, two years after MSFC announced *Saturn V* stages would be tested here, finds work progressing rapidly on construction of facilities to support the Manned Lunar Landing Program.

Great gaping scars of yellow clay dot the country side, marking the locations of test stands, support buildings and canals to service the test center.

Contracts to prepare sites have been let in profusion and the Corps of Engineers is in the process of awarding more contracts for "brick-and-mortar" work.

Largest of these to date is $13,000,000, awarded to C. H. Leavell and Co. and Peter Kiewit Son's Co. of El Paso, Tex., for construction of a single-position test stand for S-II stages. This is the first of two such stands to be built along a branch of the main canal serving the test site.

Design of the brick-and-mortar portion of this stand was finished several weeks ago. Design of the second S-II test stand is now at the 30% level, but no date has been set for opening bids on the structure.

Second-largest construction contract to be let this calendar year will be the navigation lock and its water supply, which will cost an estimated $7.2 million. This conventional-type lock will lift barges 20 ft. from the East Pearl to the level of the canal system servicing the test stands.

Test facility spokesmen say the lock is a pacing item because transportation of stages and supplies to their destinations depends on availability of water transportation.

Many smaller contracts also have been issued and Corps spokesmen estimate the total will reach $140 million by next June.

- **Granddaddy stand**—Included in that amount will be construction of the two-position S-IC test stand, which will cost an estimated $38 million.

Excavation and pile-driving already is under way for this huge structure, which will dominate test activities here for many years to come.

The initial phase of the S-IC test stand construction should be completed by next January, when a contract will be let to install the concrete substructure to support the test stands. It will measure 378 x 146 x 40 ft. and be of cellular construction. Some of the rooms in the substructure will be used to house test equipment.

Most of the construction work at the test facility is now on schedule. The S-II test stand is due for completion in April, 1965, when the S-II facilities checkout vehicle arrives from California. The first flight stage is due in the fall of 1965.

Fortune said great emphasis is being placed on completion of the entire S-II test stand complex on schedule.

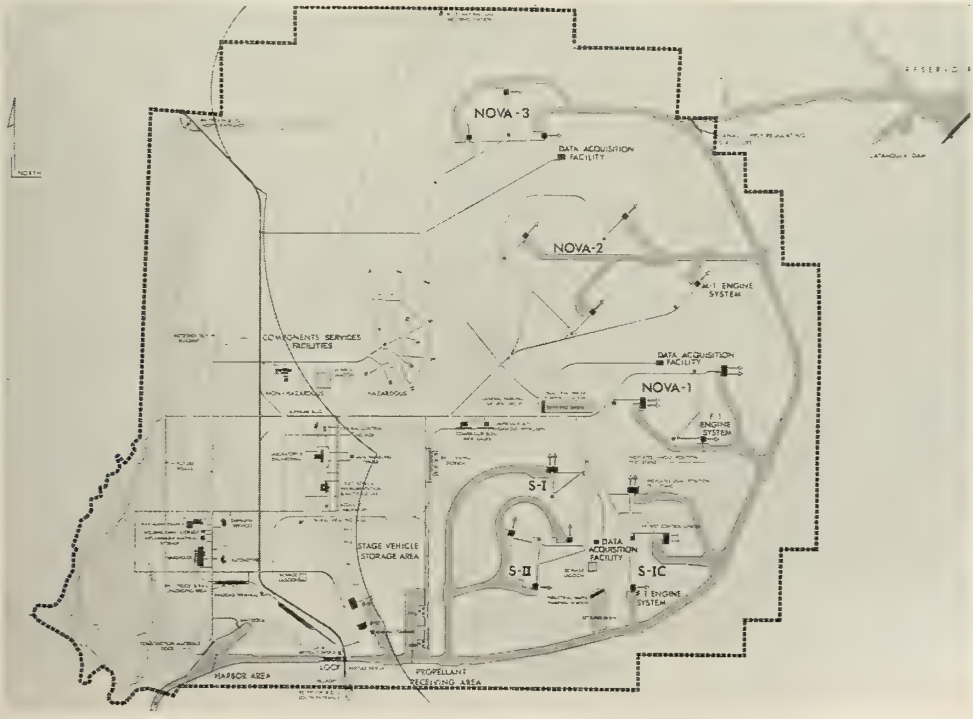
"We do not intend to allow the S-II data acquisition facility, central control tower, data-handling facility or other direct support to lag," he said.

"If necessary, we will reprogram to assure that the S-II stands will be ready on time, since the stands are the pacing items for the center operation.

"But if hardware problems or construction delays occur, we will not pay premium wages to catch up if the stage is delayed."

The critical requirement for S-II stands here is pointed up by the fact the maximum test run permissible at the Santa Susanna test site in California is 25 sec., while S-II stages will be given full duration, 400-sec. runs here.

The S-IC test stands are due for completion by October or November, 1965, but the flow of appropriations may upset this target date. However, the S-IC stand at Marshall will be completed earlier, and the first two S-IC stages to be tested will be fired at MSFC. Additional firings could be conducted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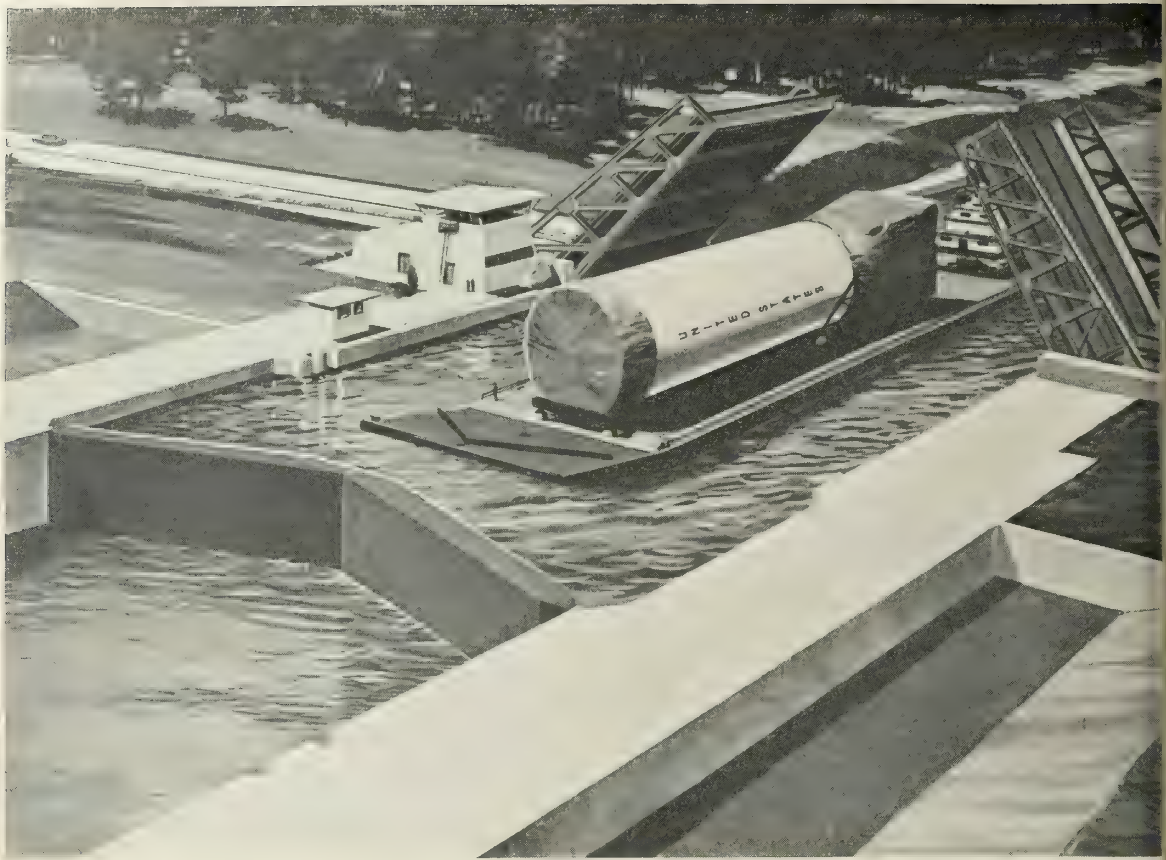


MISSISSIPPI TEST FACILITY'S lock and bascule bridge on East Pearl River.

there if Mississippi Test Facility stands are not completed on schedule.

While the "brick-and-mortar" work is still proceeding, there will be some joint occupancy of facilities as data-retrieval systems are installed on some test stands.

- **Support work**—Instrumentation systems for the first S-II test stand are being designed by Aetron, a division of Aerojet-General Corp., under an $18,254,000 contract awarded last July by MSFC.

The contract covers design, procurement and installation of equipment for the control center, data acquisition facility, data handling center and the test stand. It also provides for Aetron to train General Electric Co. personnel in its use.

Similar contracts are to be issued later for work to be done on the S-IC stand, the second S-II stand and other support facilities of the test center.

The stage contractors are scheduled to get a large portion of their data by telemetry through the data-handling facility. Hard lines will transmit environmental measurements from the test stand to the data acquisition facility.

Personnel of the General Electric Co., prime contractor for support services, will acquire and reduce the data and provide the first copy to the stage contractor. Copies will be furnished to NASA when needed.

The initial portion of General Electric's support services at the test center covered activation studies. Later, the firm will provide many other services such as road and building maintenance, food service, motor transportation, plant security, fire protection and operation of the railroad marshalling yards and two switch engines. Many of the services will be subcontracted.

By 1966, when the test center is running at a normal rate, General Electric and its subcontractors will have between 1,500 and 1,800 employes. The Boeing Co., producer of the S-IC stage, and North American Aviation, manufacturer of the S-II stage, will each have about 300 employes on the reservation. NASA's civil service complement will number between 150 and 200.

- **Planning ahead**—Mississippi Test Operation activities are closely monitored by a planning board jointly headed by Capt. Fortune and Karl Heimburg. These men, together with a group from MSFC, meet monthly to review programs and funds, and to determine policy and guidance for the working group.

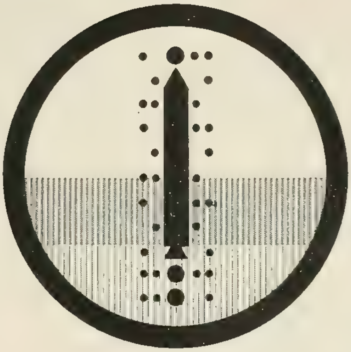
This latter group, now located a MSFC in Huntsville, does the planning for the test center. Its membership is made up of General Electric personne and representatives of interested NASA offices at MSFC. It handles such matters as developing general design criteria for facilities and testing.

Long-range planning for the test facility will continue to come from Marshall, since the test site reacts to booster developments at MSFC.

The planning already has located sites for 10 *Nova* test positions along the canals and a site for a two-position stand to test S-I stages of *Saturn*.

Since the S-I program is due to terminate soon, consideration is being given to eventually asking for funds to erect a test stand on this site with provisions for handling an S-IB stage on one side and an advanced engine on the other side.

MTO officials see an eventual need for another S-IC test stand, but no requests are in the mill for funds at this time. ∎



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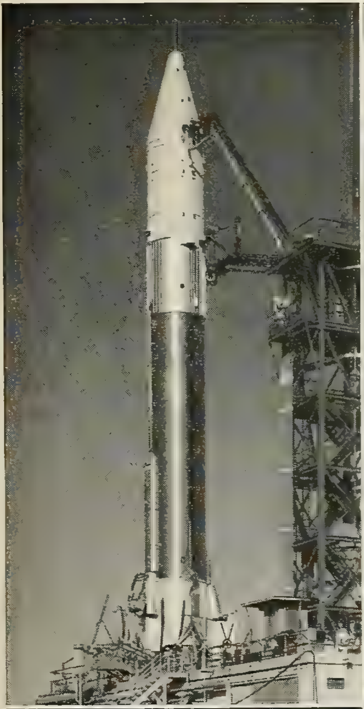

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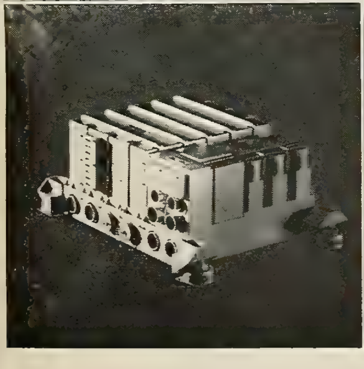

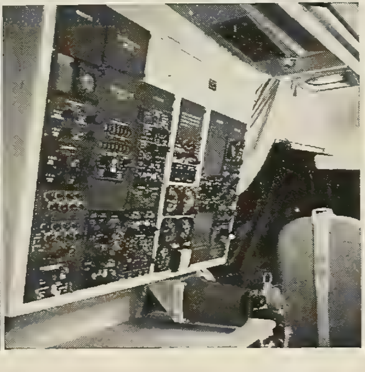

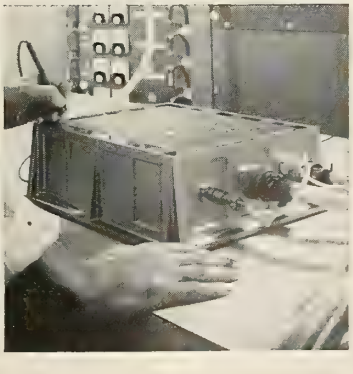

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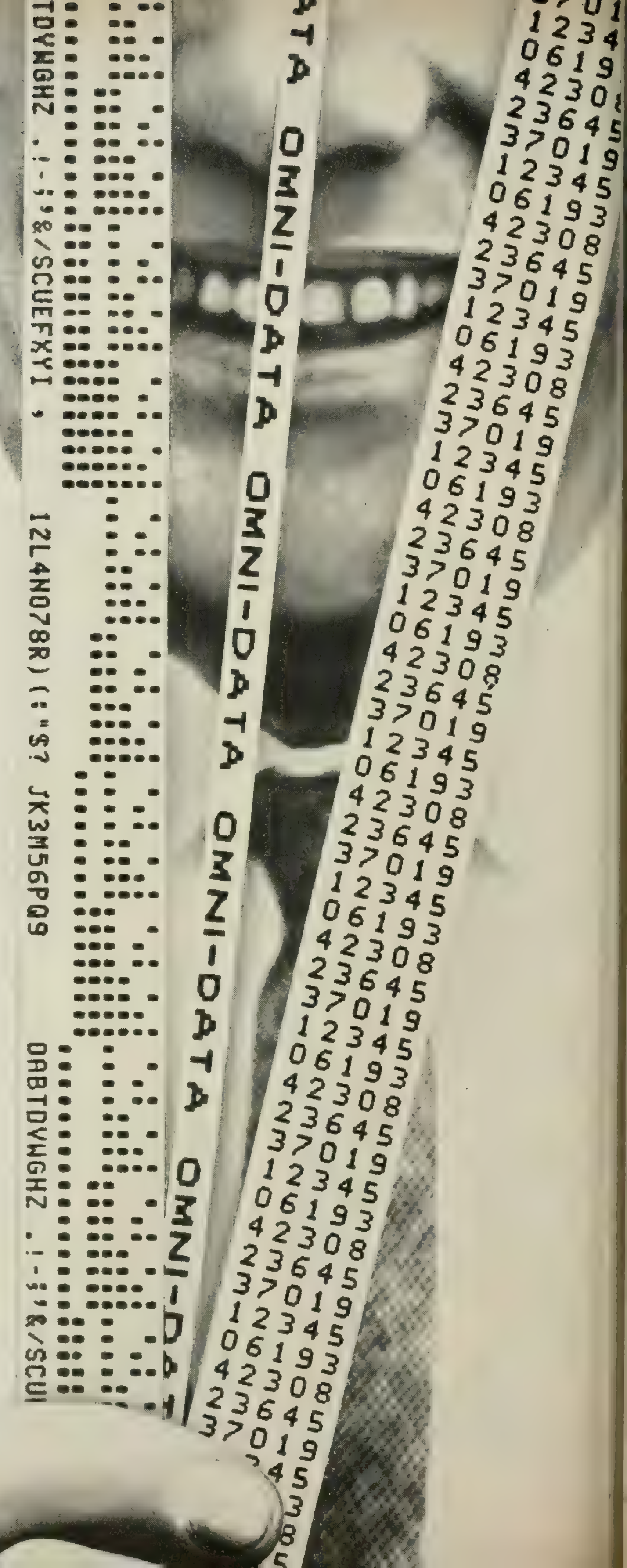
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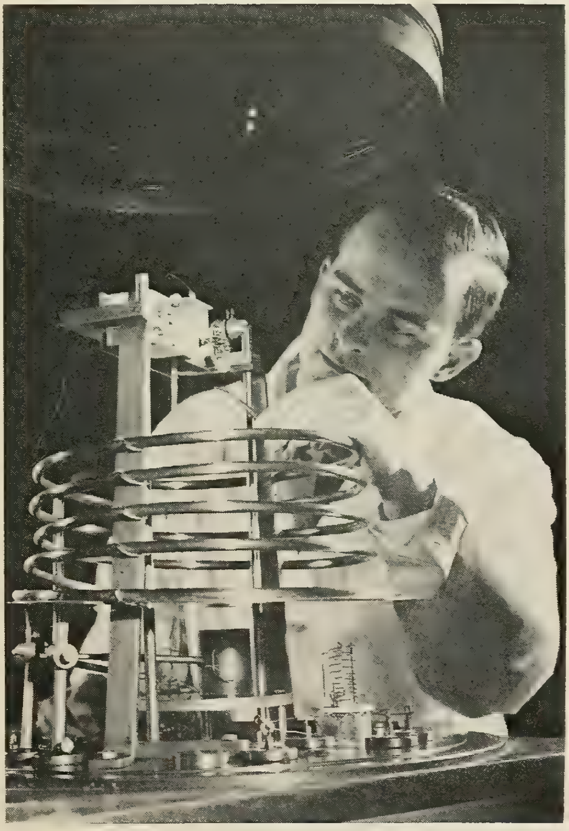
Lewis Will Invest Half A Billion in Fiscal '64

Drive to exploit field installations accelerated by new program-direction roles including Centaur



FINAL ADJUSTMENTS are made on a liquid gallium evaporation test apparatus. Results from such low evaporation tests gave Lewis researchers their first hint that the element might make an ideal lubricant for use in space.

CLEVELAND—More than $500 million in develoment funds will be pumped through NASA's Lewis Research Center to industry in Fiscal 1964—compared with about $70 million in Fiscal '61.

But the center's basic mission—propulsion and space power research—will be unchanged, says Director Abe Silverstein. The new look at Lewis represents a trend toward maximum use of the agency's field installations—a point Silverstein has been emphasizing for a number of years.

The increase in development stems from shifting the *Centaur,* M-1 and *Agena* programs to the 22-year-old Cleveland facility. The programs—especially *Centaur*—give Lewis a chance to put its test philosophy and ability into effect.

Silverstein says the plan is to extend ground-test technology to entire vehicles, and a strong effort is being made to acquire maximum performance knowledge from such shakedowns.

In spite of this emphasis, all of the center's programmed facility money will be spent to upgrade or add to existing facilities. No new installations are planned for the *Centaur* program.

And a large portion of the Fiscal '64, $18 million-plus facility funds will be used to beef up the center's research and testing equipment in advanced propulsion areas.

The general objectives of Lewis have broadened to include a higher order of development activity. But the basic and applied research areas at the center are not suffering.

Lewis still is concentrating on basic in-house work supporting its overall propulsion and power responsibilities. This covers materials and metallurgy, cryogenic and liquid metal heat transfer fluids, pumps and turbines, combustion processes, propellants, tankage, injectors and nozzles.

Other active programs are concerned with system control dynamics, plasmas and magnetohydrodynamics, space meteoroid damage and zero-g effects. There is work on turboelectric, thermoelectric and thermionic energy-conversion systems.

The center operates the agency's only nuclear reactor—a 60-megawatt thermal installation at the Plum Brook Station. The reactor is in operation and will be used to study nuclear radiation effects on materials and components.

The major research tools and facilities at Lewis—including Plum Brook—are designed to simulate various flight conditions. These range from atmospheric wind tunnels to large space environmental facilities.

Other representative facilities include vacuum electron-beam furnaces for tungsten and other refractory metals refinement, liquid metal power loops, chemical rocket static-thrust stands and a full-scale non-nuclear *NERVA* stand for study of engine control dynamics.

Lewis is materials-oriented and covers the field from near absolute zero to the extreme temperature regimes associated with high-performance nozzles. Very little structural work is done at the center unless it is peculiar to the area of competence—such as cryogenic containment.

The Fiscal '64 funds allocated to facilities improvement and construction just about finish all planned installation work at the Center. The Fiscal '63 funds—about $43 million—covered a major portion of this work.

Some of the major innovations expected in the next year are as follows:

- **Spacecraft propulsion research facility**—Approximately $3.15 million will be spent in providing a space environment simulation capability to an existing facility. The addition will allow complete functional tests including space starting and operation of rocket engines.

The facility will be able to handle vehicles up to 50 ft. long and 32 ft. in diameter with thrust levels up to 45,000 lbs., using high-energy propellants. Space storable propellants can be checked out to 50,000 lbs. of thrust.

To provide the space soak capability, the test chamber will be equipped with a vacuum pumping system capable of maintaining a 10^{-8} torr pressure levels. The walls will be lined with cryogenic heat-sink panels which use liquid nitrogen and liquid helium.

All of the stages in the current *Apollo* vehicle can be accommodated as well as advanced conceptual designs with larger nozzle diameters.

Functional testing possible with the modified chamber will cover control valves, fuel vents, engine gimbal actuators, ignition systems, pumps and control sensors—all in a simulated space vacuum and temperature environment.

- **Space-power chamber alteration**—The Lewis high-altitude wind tunnel will be modified to handle evaluation and development testing of full-scale propulsion systems in a simulated space, planetary or lunar environment.

The facility will permit functional investigations into propellant heating, valves, insulation effectiveness, countdown procedures, system behavior and pressurization requirements. Thrust build-up and thermal distortion in the system structure also can be examined.

The entire space-power chamber will be built around the current high-altitude test facility. This complex includes the large exhaust gas cooling and pumping system of the center, together with basic structure, control rooms and service facilities.

- **Electric power equipment test facility**—Modifications to equipment and buildings will permit the testing of electrical generating, power-conversion and control components of electric space power systems.

One large test cell will accommodate a cradled motor and gear assembly drive for fractional megawatt electromagnetic generator tests. Two small test cells will be utilized for small-magnitude electromagnetic and electrostatic generator test stands.

All of these cells will simulate space conditions.

- **Propulsion component evaluation**—Operational characteristics and the reliability of propulsion components under space environments will be evaluated in a series of test facilities covering vacuum, temperature and physical parameters such as vibration and endurance.

- **Zero-gravity facility**—About $2.6 million will be spent in Fiscal '64 to provide Lewis researchers with 10 seconds of a near-zero-gravity environment for liquid/vapor studies. The facility will consist of a 20-ft.-dia. steel chamber, 400 ft. long, evacuated to a pressure level of 10^{-2} torr. The chamber will be positioned eccentrically in a concrete shaft 510 ft. deep and 28.5 ft. in diameter.

The top of the shaft will be enclosed by a 48-ft.-high service building containing the vacuum pumps, model preparation area and a crane. A single-story adjunct to this building will house the control room, office and a "cleanroom" for preparing test specimens.

A deceleration mechanism located at the bottom of the 400-ft. free-fall chamber will retreive specimens without excessive damage.

For times up to 5 seconds, the experiment will be dropped from the top of the shaft, while 10-sec. runs will necessitate acceleration from the bottom and recovery after traversing the 400-ft. chamber twice.

Compact experiments will be enclosed in a heavy outer-drag shield and allowed to float freely so that, as it is held back by air resistance, the experiment can still follow the free-fall path. This method will permit rapid testing.

A second approach for those experiments too heavy and unwieldly for a drag shield involves chamber evacuation. The specimen drops in a practical vacuum. Total pressure levels can be reached in about an hour.

The effects of weightlessness is a prime factor in the design of all spacecraft and other propulsion/power systems. The systems proposed for study in the 400-ft. chamber include the positioning of liquids and vapors in propellant tanks and in the condensors and evaporators of space power generation systems.

The behavior of the liquid/vapor interface in zero-gravity affects engine restarting, tank venting, propellant transfer during rendezvous, and the proper operation of auxiliary power systems.

Lewis researchers have been using a 100-ft. drop test facility, but this allowed only 2 seconds of zero-gravity time—far too low for intelligent scale-up data. The 10-sec. test bed also permits model sizes in the 2-to-4-ft. area instead of the 5-10-in. capability now available.

The new drop-test complex should provide the data needed for full-scale extrapolation to vehicle systems—including the *Apollo* program.

- **Advanced hardware**—NASA's only *Nova*-type development program is operated out of Lewis—the 1.5 million-lb.-thrust H_2-O_2, M-1 engine.

Engine hardware fabrication is well under way, although the entire program is being funded at a lower level than originally anticipated. When the original 1963 cuts were made, NASA already had embarked on a review of the engine which resulted in raising its vacuum thrust level from 1.2 million to the current 1.5 million lbs.

Slightly over $90 million already has been spent on the M-1 program, and total cost through development is estimated to be $200 to $250 million. The engine has no specific mission yet and closely resembles the initial F-1 program.

The powerplant is slated for a 6-to-8-year development period, starting from calendar year 1962. For planning purposes, the M-1 figures in many of the current *Nova* studies and the program represents a realistic concession to vehicle development lead times. The engine is by far the pacing element.

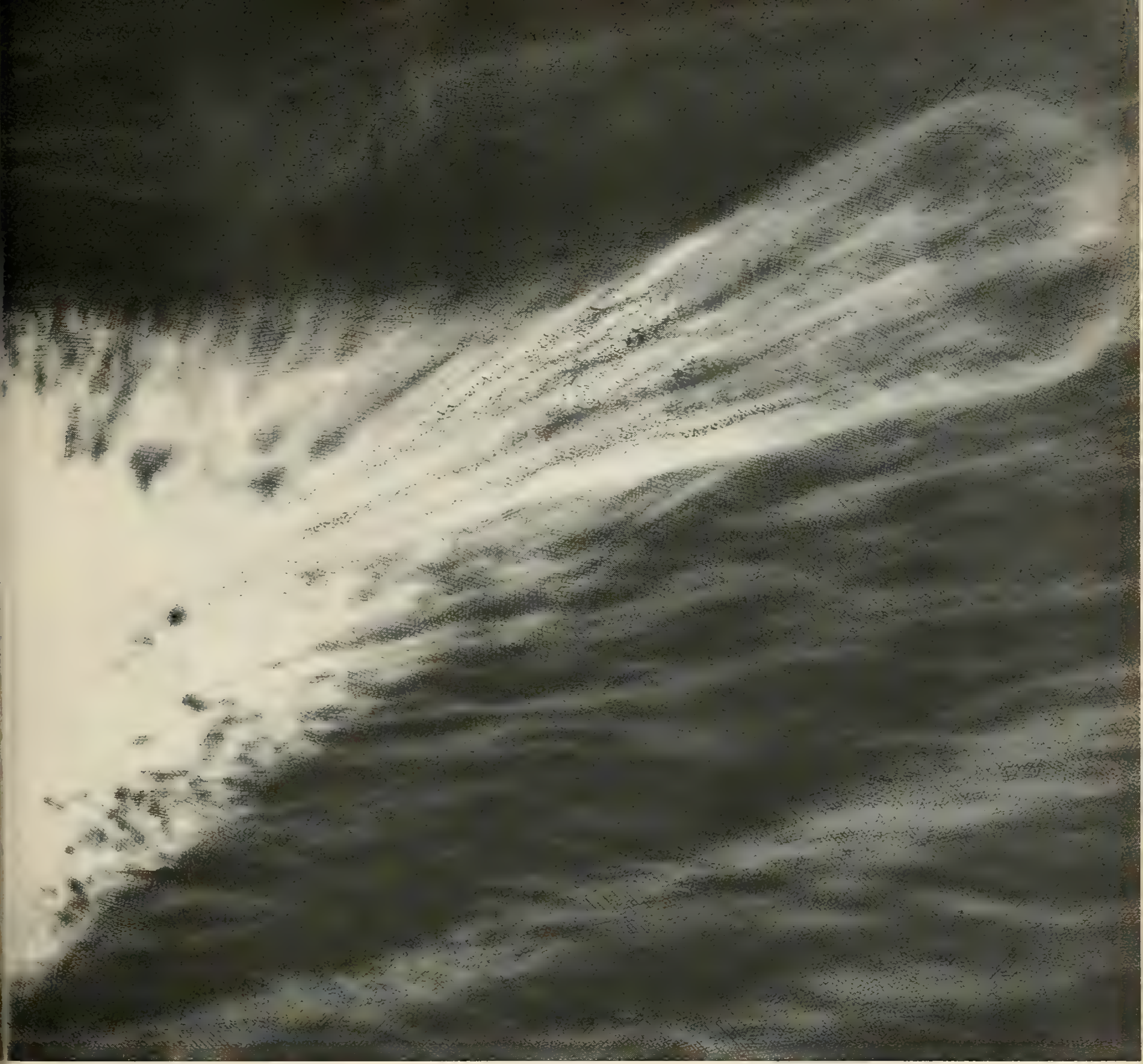
Current M-1 design allows for a growth potential in both thrust and performance above the specified 1.5-million-lb. rating.

The M-1 Project Office at Lewis is part of the Chemical Rocket Systems Division under I. A. Johnson. W. F. Dankhoff manages the program and the M-1 procurement is handled by J. A. Durica.

The M-1 office at Lewis functions as part of a single team with the contractor's management setup. Aerojet General is the industrial half of the team. But all the checks are signed at Lewis and program authority rests with Dankhoff.

The Lewis group is functionally a small replica of the Aerojet development organization. The system leads to quick responses in the various development problems normally associated with such an engine program.

Under Dankhoff, the office is broken into the following areas: En-



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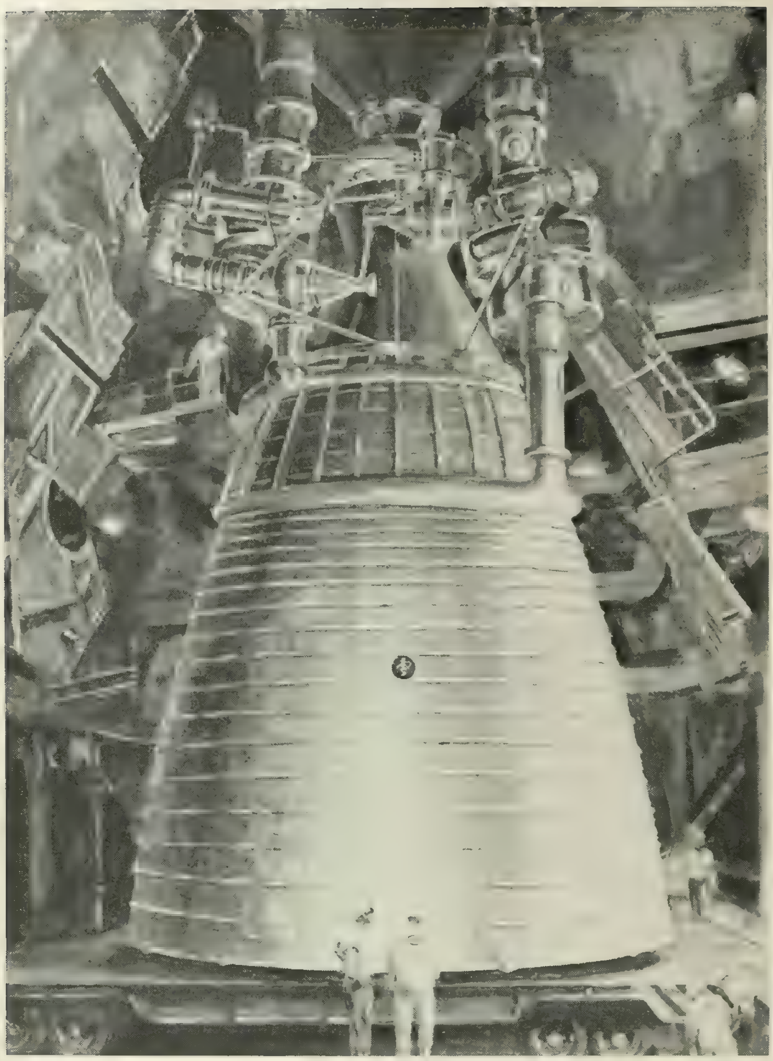


ARTIST'S CONCEPTION of the Aerojet-General/Lewis M-1 engine on launch pad.

gine Systems—F. Wilcox, Engine Controls—R. Willoh (Acting), Turbomachinery—W. W. Wilcox, Thrust Chamber—W. Tomazic and Facilities —W. H. Rowe.

Durica's procurement activity is physically a part of the M-1 office but follows its line of authority through the center's procurement set-up. Reliability and Quality Assurance personnel from the center work with the M-1 group. There also is a working interface with the *Nova* systems study groups at Marshall Space Flight Center.

Major M-1 test facilities will be located at the Aerojet-General Liquid Rocket Plant in Sacramento, Calif. Plans call for four new test stands to handle all phases of the 400-test M-1 engine program.

The stands will accommodate intermediate testing in the 300-sec. area and then the ultimate 500-sec. tests. An altitude simulation capability also is planned, since the M-1 is initially aimed at upper-stage use.

• **Centaur and Lewis**—The basic changes in the *Centaur* program following the program shift to Cleveland are concentrated in the test area. The *Centaur* vehicle will be the most thoroughly ground-tested propulsion system in the history of the space agency.

The *Centaur* project office under D. S. Gabriel at Lewis reports directly to the Center's associate director for development, B. T. Lundia. The group was formed from Lewis and NASA personnel and draws on over 10 years of experience in hydrogen propellants at the center.

Long before the *Centaur* program moved to Lewis, the center had been using the RL-10 engine as a test bed. Two RL-10 units power the *Centaur* vehicle.

Wind-tunnel separation tests with a full-scale *Centaur* vehicle have been in progress at the center for some weeks. A 130-ft. shake stand at the Plum Brook installation is being modified for use with an *Atlas/Centaur* combination.

In spite of the increased emphasis on testing, no new facilities have been necessary at the center for the program. Instead, the agency has modified old and standard equipment.

A combined systems test stand is under construction at General Dynamics/Astronautics for the *Centaur* program. This stand will essentially cut down test procedure time at the launch site while checking out each evhicle before delivery to the Cape.

E. R. Jonash, part of an operating triumverate, handles *Centaur* propellant systems, propulsion, materials and structures and test engineering under Gabriel. J. C. Nettles oversees electrical and mechanical ground support, instrumentation and guidance. D. D. Rovenger is in charge of engineering and vehicle integration.

L. C. Perry is in charge of *Centaur* procurement and supply, including the resident procurement personnel at the contractor's San Diego plant.

• **Operational engines**—All *Agena* vehicle procurement for NASA is handled through Lewis. This generally covers missions such as *Ranger, OAO, OGO, Mariner* and *Nimbus.*

The basic function of the office, under Dr. S. C. Himmel, is to resist changing the *Agena* as much as possible. The idea is to keep it a standard launch vehicle.

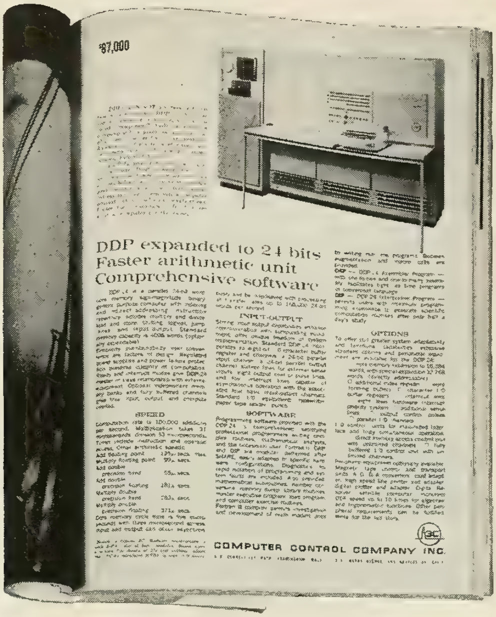
Any mission-oriented changes in the vehicle are in the nature of adaptations rather than modifications—and there is still an effort to so perform the engineering as to generalize its effect.

The standardization emphasis extends to *Agena* stage adapters and payload shrouds. The Lewis *Agena* Office is responsible for procurement of a specific vehicle for the particular mission and follows through right to the launching pad. Himmel and his staff actually are relieved of responsibility only after the *Agena* has completed its mission.

Thus all requested changes are examined from the standpoint of what else might be affected on the vehicle.

None of the three new areas within Lewis is intended to set a pattern for the future. There is no intention, for instance, of establishing an *Agena*-type organization to handle the operational *Centaur*. But the possibility is strong that this may occur when the vehicle reaches flight status. ■

DDP- 24 digital computer introduced March, 1963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DDP expanded to 24 bits
Faster arithmetic unit
Comprehensive software

COMPUTER CONTROL COMPANY INC.

~~17~~ 29 Orders to date* including . . .

Three DDP-24 Computers To EAI For Hydac — 2400

FRAMINGHAM, MASSACHUSETTS — Electronic Associates, Incorporated, Long Branch, New Jersey, has ordered three DDP-24 general purpose digital computers from Computer Control Company, Inc. The three computers were ordered as part of a continuing EAI/3C contract by which 3C supplies the digital portion of EAI's new HYDAC-2400 — the first standard, commercially available analog/digital computer system. The design of the HYDAC-2400 provides for the system to function as a totally integrated unit and also as separate analog and digital computers.

3C Delivers DDP-24 Computer For Gemini Trainer

FRAMINGHAM, MASSACHUSETTS — Computer Control Company, Inc., delivered the first of two DDP-24 Digital Data Processors ordered by McDonnell Aircraft Corporation for use in the Gemini Flight Trainer System.

The DDP-24 will be the basic computer in the system and will provide real-time simulation of the on-board guidance computer through all phases of launch, boost and insertion, orbit, rendezvous and docking, retro and re-entry, and letdown.

NASA Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A DDP-24 Digital Data Processor has been ordered from Computer Control Company, Inc., by NASA for the Goddard Space Flight Center.

The high speed, general purpose computer will be used as a simulator for a world-wide tracking network for manned spacecraft. Data will be utilized in determining vehicle orbits, prediction of landing sites, etc. The DDP-24 is supplied with a compre-

Litton Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Litton Industries for their Communication Sciences Laboratory in Waltham, Massachusetts.

Litton will use the high speed DDP-24 for open-shop scientific and engineering computation. Included as part of the standard DDP-24 contract agreement is a comprehensive software package including FORTRAN II and 3C engineering support services.

Air Force To Get 3C DDP-24

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by the Air Force Systems command, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

The Air Force will use the high speed DDP-24 for on-line data format conversion and also off-line for general purpose computation. Included with the DDP-24 is a comprehensive software package

3C DDP-24 Slated For Haskins Lab

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Haskins Laboratories, Inc., New York, N. Y. Haskins will use the very high speed, 24-bit word DDP-24 for applications in speech simulation

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* ~~OCTOBER 30, 1963~~ NOV. 19, 1963

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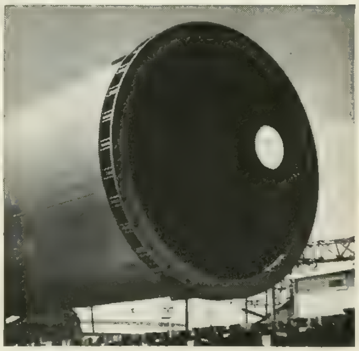
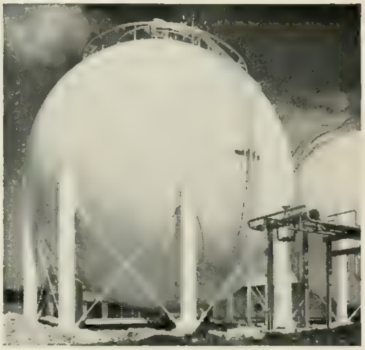
Strange things happen in the world of ultracold. Some metals get stronger b
sometimes so brittle they shatter like glass. Others become superconducto
The load-carrying capacity of some fluctuates wildly. Material selection, in th
strange Pandora's Box world, must depend on carefully accumulated perfor



This 56-ft.-long absorber unit is fabricated of A212 steel plate, popular for services requiring notch toughness down to —50F.



USS "T-1" Steel's excellent notch toughness, high strength, and weldability permit high working stresses in low temperature service.

This 2¼% nickel steel static altitude t
chamber operates at temperatures rang
from —65F to 500F.

ASTM A201 and A212: for many years the only low-temperature steels available

These two carbon steel grades are widely used for a variety of applications requiring notch toughness down to —50F, such as refrigerated vessels for the storage of liquid propane or ammonia.

ASME allowable design stresses (¼ tensile) are 15,000 psi for A201 Grade B and 17,500 psi for A212 Grade B steels.

Both grades are available in flange or firebox qualities. When specified to meet the impact requirements of ASTM A300 to —50F, the plates may be furnished in the normalized or normalized and stress-relieved condition to meet the minimum requirements for the specific application.

This mark tells you a product is made of modern, dependable Steel.

USS "T-1" Steel: can cut pressure vessel weight up to 50%

USS "T-1" Steel combines great strength (100,000 psi min. yield strength), weldability, and low-temperature toughness (15 ft.-lb. min. Charpy keyhole at —50F). It is particularly suited for highly stressed pressure vessels operating at temperatures down to —50F, tank trucks for hauling LP gases, and welded lightweight structures.

Present allowable ASME stress for "T-1" Steel is 28,750 psi for plates up to 2" thick. In non-Code vessels, "T-1" Steel has been used at allowable stress levels as high as 50,000 psi.

In a series of dramatic burst tests, USS "T-1" Steel vessels withstood internal hydraulic pressures up to 2850 psi at about —45F before bursting, equivalent to a circumferential stress of 136,000 psi. Another series of "T-1" vessels, refrigerated to about —45F and pressurized to 1875 psi, were tested to destruction by impact from a 13-ton ingot dropped successively from 52, 73, and 101 feet. An impact energy of nearly 2,700,000 ft.-lbs. was required to rupture the vessel.

USS 2¼% Nickel Steel:
down to –75F

2¼% nickel steel has been used wide
for tanks, vessels, and piping handli
liquid propane and other liquefied gas
at temperatures down to —75F. It h
been used particularly by the chemic
industry for process and containme
vessels. Specialized uses include equi
ment such as static altitude test cha
bers operating at temperatures as l
as —65F to simulate 75,000 ft. heigh

2¼% nickel steel is governed
ASTM A203, Grades A and B. Grade
is most widely used because of its allo
able design stress of 17,500 psi compar
to 16,250 psi for Grade A.

These steels are also covered
SA-203 of the ASME Boiler and Pr
sure Vessel Code.

nce data. We have a wealth of such data at United States Steel, plus compar-
ive design studies, that will make your material problems easier. Ask for a USS
yogenics specialist by calling our nearest sales office, or writing United States
teel, Room 6835, 525 William Penn Place, Pittsburgh, Pennsylvania 15230.

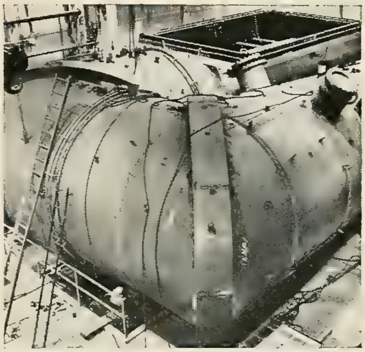
-stress-relieved 9% nickel steel vessel
refrigerated to —320F, pressurized to
ure—at four times ASME allowable stress.
e ductile manner of failure.

SS 9% Nickel Steel: cellent strength nd notch toughness own to –320F

veloped, tested, and proven for cryo-
ic service, 9% nickel steel offers a
e combination of high yield strength,
ghness, and weldability. It is partic-
rly suited for large-tonnage oxygen
ducing equipment, and for the trans-
tation and storage of liquid methane,
gen, nitrogen, and argon. Because it
sn't require stress relief after fabri-
on in most shell thicknesses, it is a
ural for large field erected tanks and
sels.

he ASME allowable working stress
3,750 psi (Code Case 1308) is more
n double that of 10,000 psi permitted
aluminum alloy 5083-0. Plate thick-
ses can be reduced to less than half
se of aluminum with sizeable reduc-
s in cost per square foot.

Vhere strength is vital, 9% nickel
l is a natural alternate for alumi-
a. Its ease of fabrication results in
stantial savings; data accumulated
late suggest savings of at least 10%
nal erected cost compared to alumi-
a vessels.

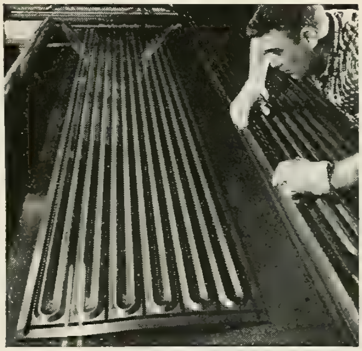


3½% nickel steel wind tunnel simulates, among other things, the frigid temperatures of altitudes up to 16 miles and over.

USS 3½% Nickel Steel: used for land-based facilities and ocean-going tankers

Low carbon 3½% nickel steel has been used for land-based facilities for the containment of liquid propane, carbon dioxide, acetylene, ethane, ethylene and other liquefied gases at temperatures down to —175F. Its excellent low-temperature toughness makes it suitable for use in shipboard tanks to transport liquid ethylene. Its formability, also excellent, has resulted in its use for tanks, vessels, piping, valves, fittings, heads, and many other components.

3½% nickel steel is covered by ASTM A203 Grades D and E. Allowable design stresses are 16,250 psi and 17,500 psi, respectively. These steels are covered under SA-203, ASME Boiler and Pressure Vessel Code.



Type 304 stainless coil heat exchanger retains strength, stability, and shock resistance in cryopump operating at —443F.

USS Type 304 Stainless Steel: the #1 cryogenic metal down to absolute zero

The austenitic chromium-nickel stainless steels, 304 and 304L, are by far the most popular metals for cryogenic service down as low as —459F. They are used widely in liquid oxygen production and storage, and the storage of liquid hydrogen and liquid helium. Wherever high purity is essential, such as handling liquid missile fuels, stainless is a must because its surface remains chemically clean and won't scale.

Type 304 stainless steel is easy to weld and fabricate, doesn't require stress relief after fabrication, and possesses high strength with excellent stability and shock resistance at very low temperatures. Its allowable design stress is 18,750 psi.

USS and "T-1" are registered trademarks.

USS United States Steel

FAR OUT FACT FINDING

...AND WHAT DOUGLAS IS DOING ABOUT IT

What will man's problems be in the vast emptiness of outer space? How will the materials and systems he will use stand up? Will his communications with earth work properly? □ At the new Douglas Space Systems Center in Huntington Beach, California, many of the required answers will be found. Part of the Center is an environmental laboratory where space "hardware" up to 30 feet wide can be tested at vacuum levels and temperatures which would be encountered 500 miles out. Other units can produce deeper space conditions down to a vacuum of 10^{-14} torr and with any required radiation and gravity situations. □ Such research facilities are basic for the development of manned and unmanned satellite systems, launching and space vehicles, earth to moon communication devices, lunar housing and vehicles, life support systems, and similar projects in which Douglas is involved.

Other research programs covering some 23 broad technological areas are under way in the major Douglas divisions located at Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

DOUGLAS

Facilities Cuts Burden Wallops Station Sounding Rocket Program

Proposed sixth launch site deleted from installation's FY '64 budget request; Scout complex, tracking capabilities to be refined

WALLOPS STATION, VA.—Parts of this support center's six-fold mission are imperiled by the current frugal mood in Congress.

The national sounding rocket program is the activity that probably will be the first to feel the impact of cuts in the station's Fiscal 1964 budget request, which originally totalled $16.9 million.

Some $2 million earmarked for construction of new facilities, including a sixth launch site north of present pads on Wallops Island (see map diagram), was termed desirable but not practical by the House Authorization Committee.

The Senate has restored $500,000 of the funds, which will be used to build sea walls and dykes to protect the south end of the island from eroding Atlantic storms. This area is also being eyed by Wallops Station officials for eventual launch site development.

Though the station's FY '64 budget request has been trimmed so far to $15.4 million, Wallops officials feel the facility will be funded at no less than $14 million for Fiscal Years '64 and '65. The appropriation could approach $17 million in FY '65 if Congress grants a request that will be made for new facilities money.

Since the station is primarily a support center, its officials can't look much beyond FY '65 in estimating a budget. They must deal in lead times of weeks or months when scheduling an experiment conceived and designed elsewhere.

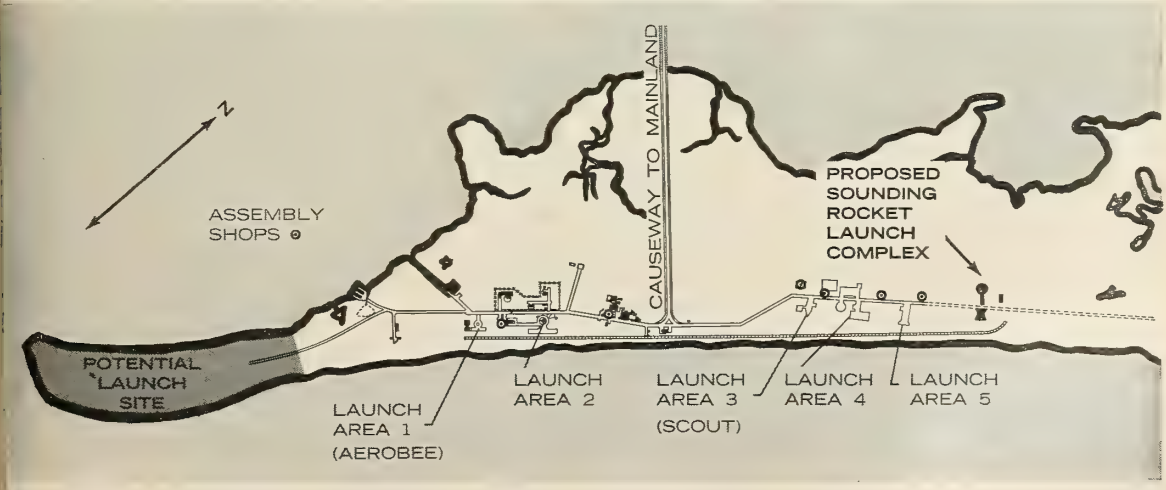
• **Mission breakdown**—Besides handling the space agency's sounding rocket program, the Wallops Station mission encompasses these other activities: launching small scientific satellites; tracking and data acquisition; providing assistance to others in training and launching, including other NASA centers, government agencies, the educational community and other nations; conducting component and systems development; conducting aeronautical research.

Wallops spokesmen feel that all these activities will continue to grow gradually over the next two years, then begin to level off. The station will ultimately be conducting some 300 launches a year, including sounding rockets, scientific satellites and re-entry vehicles.

Sounding rockets—Sounding rockets can be launched from four of the five pads on Wallops Island. Officials of the station's Range Engineering Division say current and planned programs using the *Javelin-Journeyman-Trailblazer* class of vehicles have saturated the capabilities of these facilities.

Thus, they will again ask for funds for the north end launch site in their FY '65 budget request. No time has been

MAP SHOWS AREAS earmarked for future development on Wallops Island, located some seven miles southeast of Wallops main base.



set for development of a south-end complex. The site is attractive to Wallops officials, however, because of the azimuth freedom it would allow for launches.

● **The lost money**—A look at the House-deleted $2-million Wallops Island construction-of-facilities request, most of which would have been devoted to the north end multipurpose launch site, shows this breakdown:

1) Site development and utility installations—$625,000. This category includes a beach-protection system at $450,000, grading and pilings at $55,000 and utility connections at $120,000. This is the area in which the Senate restored $500,000.

2) Facility construction and modifications—$785,000, including a 3,600-sq.-ft., $430,000 blockhouse; an 11,000-sq.-ft., $265,000 vehicle-assembly shop; and a 300 x 280-ft. launch pad costing $90,000.

3) Equipment, instrumentation and support systems—$460,000, including a $150,000 general-purpose launcher, $180,000 worth of roll-back shelters to protect against the island's exposed location and severe winters, and $130,000 in instrumentation cabling.

4) Design and engineering services —$130,000.

Range Engineering Division officials say the new north-end pad and launcher would not only allow more flexibility in launch scheduling, but would also provide a backup capability in the event of damage to existing pads.

● **Preparing for new Aerobee**—Additional considerations in the sounding rocket program involve the station's future use of Aerojet-General Corp.'s *Aerobee 350* vehicle. The liquid-fueled rocket will boost a 300-lb. payload to 300 mi.

The vehicle is being developed under a Goddard Space Flight Center contract. Its adoption will require geometrical modifications costing about $200,000 to the 160-ft.-high *Aerobee* launcher at Wallops. This money is in the FY '64 Wallops Station request.

—*Small scientific satellites*—Expansion of the *Scout* launching capability is the most pressing goal in Wallops Station's scientific satellite program.

The four-stage *Scout* is the largest vehicle presently launched from Wallops Island. Only four satellites have been boosted by the *Scout* from Wallops since 1961, but station officials expect a speedup in the program. The four shots to date were *Explorers IX, XIII* and *XVI*, plus a secret satellite launched for the Air Force last June.

All these shots were sent aloft from a 106-ft.-high vertical tower located at launch area No. 3. A second, more flexible *Scout* launcher is being built at the site. It will be operational soon, and consists of a dolly on which the *Scout* is assembled, then moved to the launcher, which engages and elevates the booster to firing position.

Range Engineering spokesmen say the second launcher could give them the capability to fire up to 12 *Scouts* in 1964, and eventually will allow 20 a year. The *Scout* project office is at Langley Research Center, and the new launcher is being constructed under a $1.685-million Langley contract with Ling-Temco-Vought Astronautics Div., *Scout* prime.

—*Tracking and data acquisition*—Wallops Station received some $4.3 million for construction of new facilities in FY '63. Most of it will be spent to improve tracking and data acquisition.

Wallops is the principal tracking station for the *Tiros* meteorological satellite series. At present, the installation is a NASA research and development effort, funded by Goddard Space Flight Center. The Weather Bureau will take over *Tiros* funding once the system is declared operational.

Slight modifications to the facility are expected as more *Tiros* satellites are launched over the next two years, but money for this work comes from the Goddard budget.

● **Big antenna planned**—A new general-purpose multiple-frequency, high-gain telemetry antenna to be built at Wallops anticipates the introduction of new frequencies in the 1,400-2,200 mc and X-band ranges by 1970. The big dish is scheduled to be operational in December, 1964.

Another installation funded in FY '63 and still to be developed is a more sophisticated range-control system that will allow real-time payload-impact prediction on shots from Wallops Island. The facility will consist of a new high-speed computer and display system with radars to be used as sensors.

The system will allow close pinpointing of splash areas for those payloads the station desires to recover.

Some expansion is foreseen for the Goddard-supported manned spacecraft tracking, engineering and training center at Wallops as the manned spaceflight program moves further into *Gemini* and *Apollo*. It is being converted from Project *Mercury*.

The role of this Wallops-located facility consists of training personnel in operation of the tracking equipment, and assembling, checking out and shipping the equipment to its site.

—*Assistance to others*—Guiding foreign nations into the Space Age probably is the area of greatest potential growth in Wallops Station's program of assistance to other groups. In addition to helping other nations, however, the facility conducts an ambitious program of meteorological and space research in conjunction with U. S. educational institutions and other government agencies. (For a more detailed report on Wallops Station's international role, see P. 149.)

● **Mobile range "lending library"**—Most foreign nations have had to begin their efforts in space research on an austerity level. With this in mind, Wallops Station engineers have pioneered a new, though modest, concept in mobile sounding rocket launch facilities.

India and Pakistan are now using the "lending library" mobile ranges furnished and maintained by Wallops. The complete system is small and simple. It consists of refurbished surplus MPS-19 radars, a computing van and appropriate launching equipment.

It costs NASA/Wallops about $100,000 to furnish the entire system, including reworking the radars, training the foreign nationals in equipment use and shipping the system and spare parts. Wallops Station is also responsible for equipment maintenance, since the borrowing nation will eventually return the system for lending to another country.

—*Component and systems development*—No new facilities for component and systems development are in the immediate future for Wallops, though FY '63 funds totalling $800,000 have been used to construct an advanced dynamic balancing complex.

New programs in the offing in this category depend to a large degree on which systems other NASA centers—principally Goddard and Langley—want to test. One Wallops official says almost all space agency hardware shots carry, and will continue to carry, components checked out at Wallops.

—*Aeronautical research*—Re-entry physics and materials studies in conjunction with the *Apollo* program and with the Air Force's Cambridge Research Laboratories comprise the most advanced aeronautical research in progress here.

The *Apollo* testing consists of attempts to crack the plasma sheath communications barrier created by bodies re-entering the atmosphere.

Laboratory studies of the communications blackout have been backed up by three Wallops launches in Langley's Project RAM (Radio Attentuation Measurements). There have also been three *Apollo* re-entry materials flights using modified *Scout* boosters, and three more are scheduled.

● **More than apparent**—Wallops officials say the station's own budget does not reflect the magnitude of the work conducted here. One spokesman pegs the total funds involved in facilities and operations at about three times the Station's annual budget, i.e., currently between $45 and $50 million per year. ■

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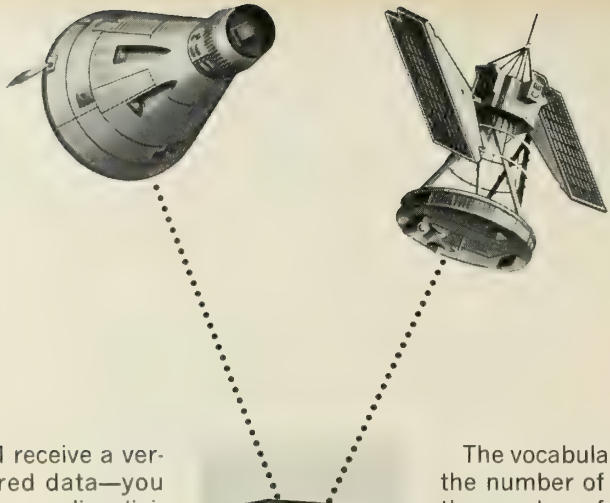

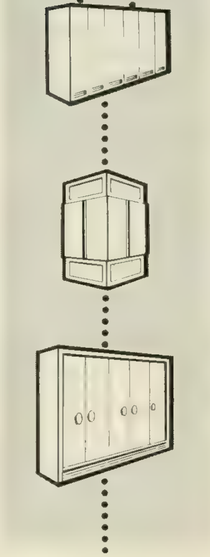

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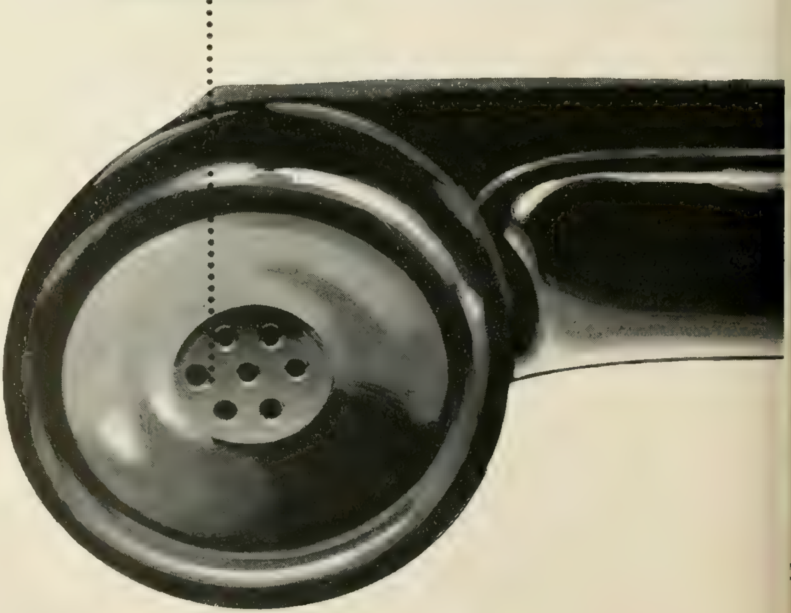

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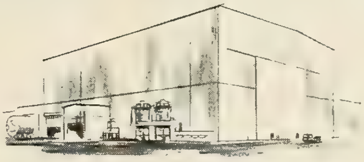

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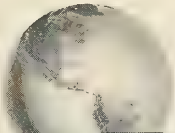

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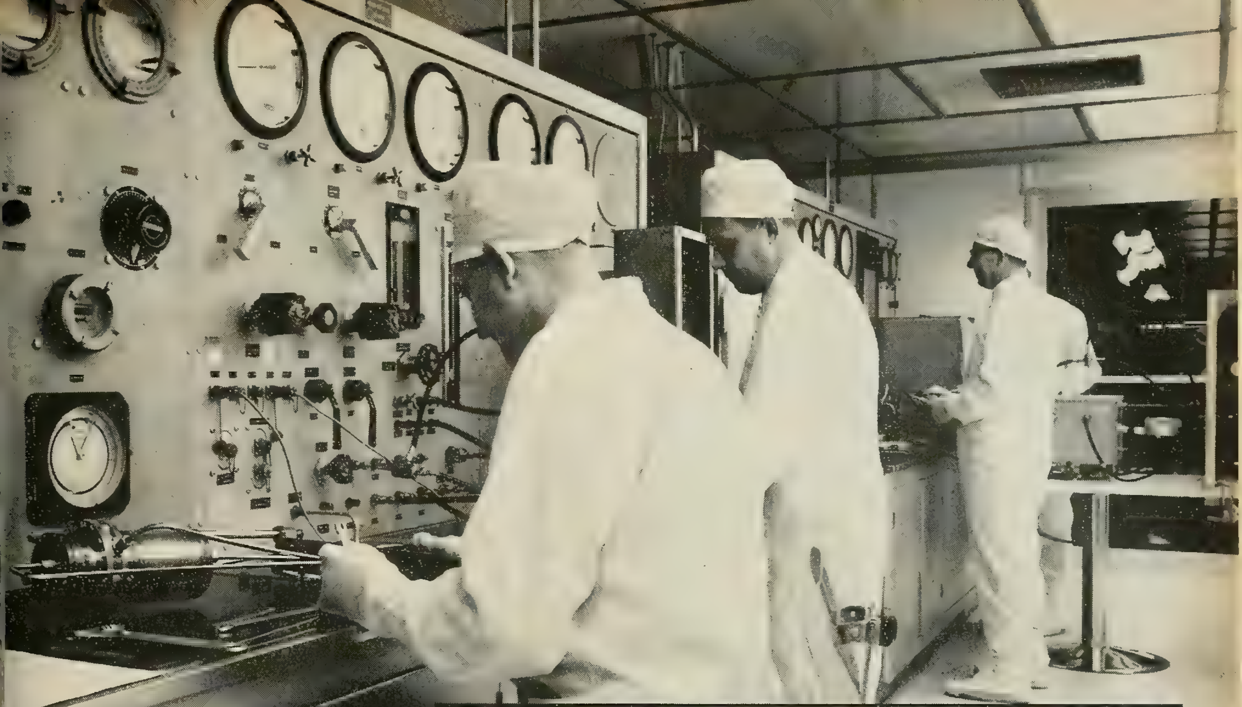

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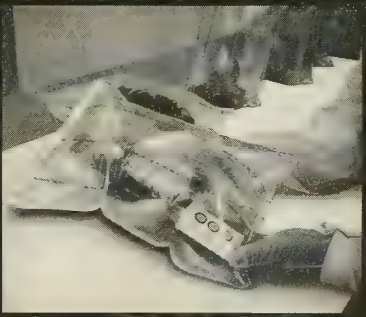

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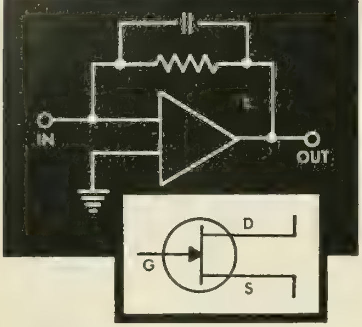

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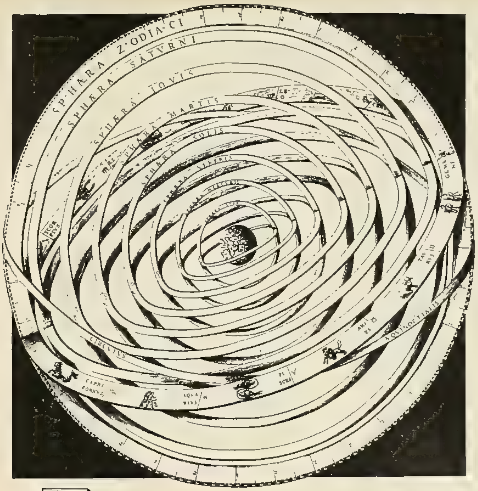

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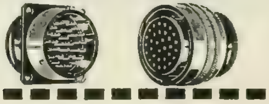

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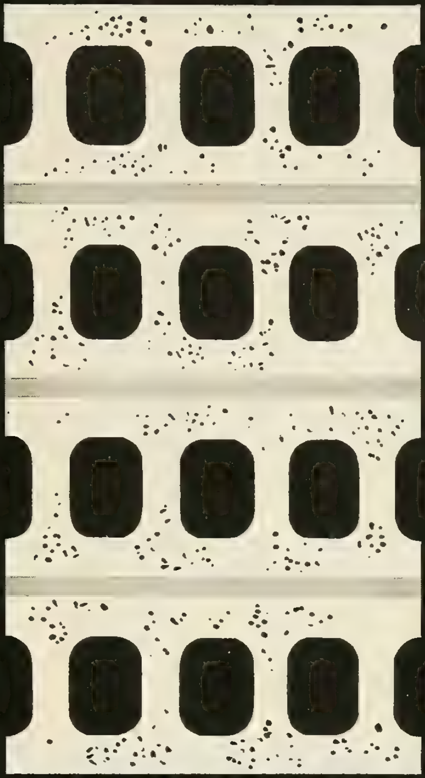

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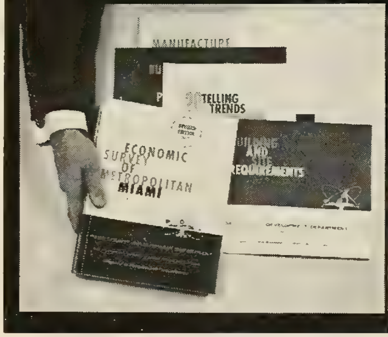

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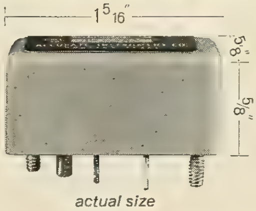

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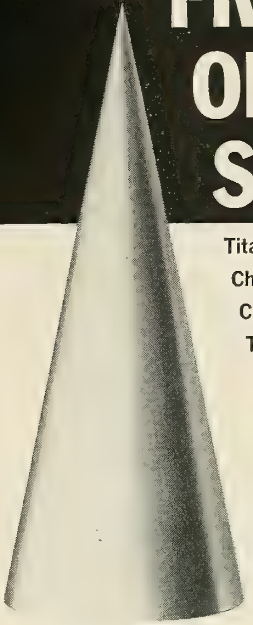

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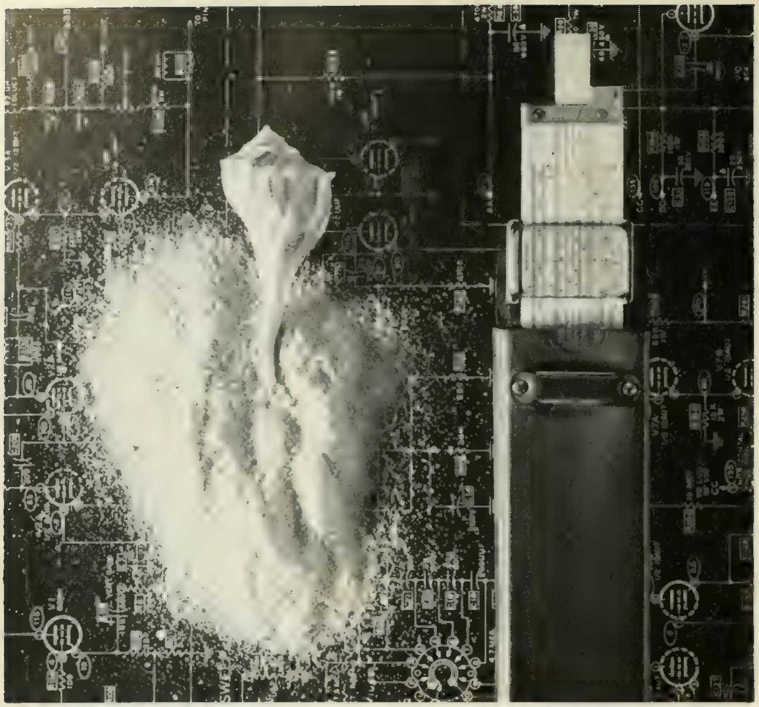

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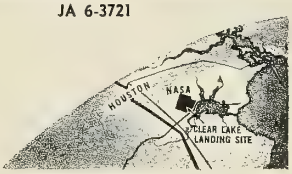

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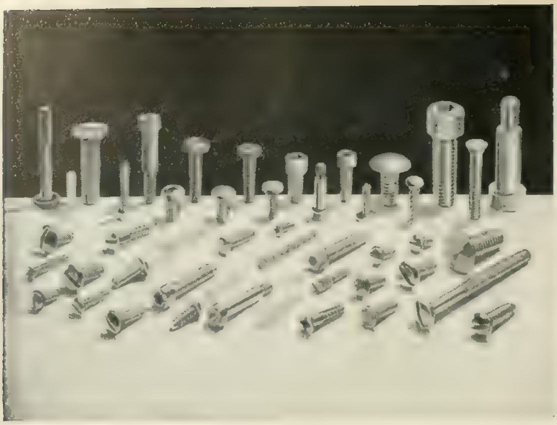

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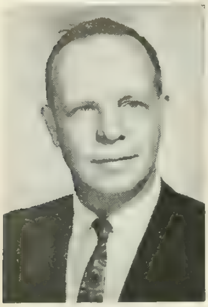

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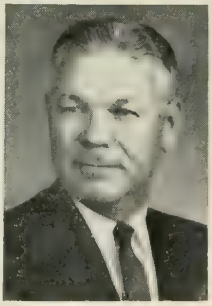

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Vernon M. Setterholm: Named president of Vitro Electronics, division of Vitro Corp. of America, Silver Spring, Md.

Daniel Davis: Appointed vice president-director of engineering of Pax Electronics Co., Inc., New York City.

William W. Wright: Joined the board of directors of the Fluorocarbon Co., Anaheim, Calif.

James C. Hill: Appointed West Coast regional manager for General Precision, Inc., Los Angeles.

Charles M. Whitley: Appointed senior district representative of the Nortronics Div. of Northrop Corp., Washington, D.C.

William D. Jenness: Appointed personnel manager of Sparton Southwest, Inc., Albuquerque, N.M.

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Dr. Paul F. Maeder: Elected president of College Hill Industries, Inc., division of Speidel Corp., Warwick, R.I.

Daniel L. Martin: Joined General Dynamics Corp., New York City, as assistant counsel.

William H. Bradley: Appointed marketing manager of Electronic Space Structures Corp., West Concord, Mass.

John H. Coulombe: Appointed staff assistant at Leach Corp.'s Controls Div., Azusa, Calif.

Robert S. Schairer: Appointed Lockheed Aircraft Corp.'s director of development planning, Burbank, Calif.

William F. Radcliffe: Promoted to assistant director of the spacecraft engineering subdivision in Aerospace Corp.'s El Segundo Techncal Operations.

Chester D. May: Joined Hoffman Electronics Corp., Los Angeles, as controller.

Dr. Howard S. Seifert: Appointed manager of United Technology Center's Physical Sciences Laboratory, Sunnyvale, Calif.

Erwin M. Sieron: Appointed president of Western Scientific Instrument Co., San Marino, Calif.

Sidney Sternberg: Joined the staff of Electro-Optical Systems, Inc., Pasadena, as vice president and general manager.

Robert J. Greenway: Appointed director of program operations at Motorola's Chicago Military Electronics Center.

Dr. George C. Sponsler: Joined International Business Machines Corp. as director of advanced planning in the Federal Systems Div., Rockville, Md.

Dr. Weston A. Anderson: Appointed director of research for the Analytical Instrument Div. of Varian Associates, Beverly Mass.

J. B. Steed: Appointed general manager of Varo, Inc.'s Electrokinetics Div., Santa Barbara, Calif.

Stuart Lotwin: Appointed contracts manager for Electroni Memories, Inc., Hawthorne, Calif.

Carl J. Oles: Appointed director of labor relations for General Dynamics Corp., New York City.

Eston D. Lawrence: Joined Northrop Nortronics' System Support Dept., Anaheim, Calif., as an applications engineer.

Michael Karp: Appointed director of market research fo Vitro Corp. of America, New York City.

Thomas R. Joiner: Appointed manufacturing manager o Leach Corp.'s Relay Div., Los Angeles.

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American Institute of Chemical Engineers Annual Meeting, Rice Hotel, Houston, Dec. 1-5.

Florida Aerospace Industry Seminar, Cherry Plaza Hotel, Orlando, Fla., Dec. 3-4.

33rd Symposium on Shock Vibration and Associated Environments, U.S. Naval Research Laboratory, Washington, D.C., Dec. 3-5 (confidential).

Electronic Industries Association Winter Conference, Los Angeles, Dec. 3-5.

Testing of Manned Flight Systems Conference, sponsored by AIAA and NASA's Flight Research Center, Edwards AFB, Calif., Dec. 4-6 (semi-classified).

IEEE Ultrasonic Engineering Symposium, Marriott Motor Hotel, Washington, D.C., Dec. 4-6.

IEEE 14th National Conference on Vehicular Communications, Adolphus Hotel, Dallas, Dec. 5-6.

International Symposium on the Stability of Polymers, Battelle Memorial Institute, Columbus, Ohio, Dec. 5-6.

IEEE Fourth Annual Seminar on the Reliability of Space Vehicles, Airport Marina Hotel, Los Angeles, Dec. 6.

Nobel Festivities and Nobel Prize Ceremony, Stockholm, Sweden, Dec. 10.

Electronic Industries Association Microelectronics Conference, Philadelphia, Dec. 10-11.

SAE Committee Meeting on Spacecraft Flight Controls, Houston, Dec. 11-13.

AIAA Conference on Heterogeneous Combustion, Biltmore Hotel, Palm Beach, Fla., Dec. 11-13.

National Vendors Meeting, Space and Flight Equipment Associations, San Diego Aerospace Museum, San Diego, Calif., Dec. 13-14.

The 60th Anniversity of Powered Flight Observance Program, Kitty Hawk, N.C., Dec. 15-17.

Conference on Non-Linear Processes in the the Ionosphere, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Dec. 16-17.

Wright Memorial Dinner, Sheraton Park Hotel, Washington, D.C., Dec. 17.

American Physical Society Meeting, Pasadena, Calif., Dec. 19-21.

American Astronomical Society Annual Meeting, College, Alaska, Dec. 26-28.

Third Western National Meeting, Space and Planetary Sciences, sponsored by the American Geophysical Union, Boulder, Colo., Dec. 26-28.

American Association for the Advancement of Science 130th Annual Meeting, Sheraton Cleveland Hotel, Cleveland, Dec. 26-30.

Society for the History of Technology Annual Meeting, New York City, Dec. 26-30.

JANUARY

Institute of Physics and the Physical Society Conference on Solid State Physics, University of Bristol, England, Jan. 1-4.

10th National Symposium on Reliability and Quality Control, Statler Hilton Hotel, Washington, D.C., Jan. 7-9.

National Society of Professional Engineers Winter Meeting, Westward Ho Motel, Phoenix, Jan. 8-11.

1964 Annual Automotive Engineering Congress and Exposition, Cobo Hall, Detroit, Jan. 13-17.

146th National Meeting of the American Chemical Society, Denver, Colo., Jan. 19-24.

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Forecast: A Stormy 1964

THE NATIONAL Aeronautics and Space Administration, badly battered in Congressional budget hearings, faces still further storms in its immediate future.

As we predicted last December, 1963 has been a very unspectacular year for NASA. There was nothing remarkable in the prediction, since a comparison of launch schedules made it quite plain that the space agency would not match its dramatic triumphs of 1962. Solid progress has been made, but much of it has been in factories and laboratories in developments which lack the glamor of flaming ascents from Cape Canaveral.

There have been, to date, only five NASA payloads launched in 1963. The result has been as expected. Congress, faced with a whopping appropriations request, was not particularly impressed with solid progress in factories and laboratories. Scrubbing of the *Ranger* shots and troubles with *Centaur* made headlines which emphasized technical difficulties not easily explained.

To Congressmen, faced with the task of justifying to their constituents a space-agency appropriation of more than $5 billion, the lack of launch activity at the Cape was a handicap. The President's failure to spring more quickly to the defense of his lunar program also made the budgetary course more difficult.

We are pleased to note that he apparently has become aware of this. His recent statements in support of the space program in general and Project *Apollo* in particular will have a beneficial effect, as will his recent visit to the Cape.

But the fact that five months of Fiscal 1964 have passed with approval of NASA's sharply trimmed FY '64 budget still pending—and still being debated in strong terms—is sufficient indication that the agency has run into stormy weather.

Nor is there any hope that the situation will ease in the year ahead. Space agency officials believe that a request for a supplemental appropriation is a must if the manned lunar program is to be held to schedule. Both NASA Administrator James Webb and manned spaceflight boss Dr. George Mueller have made that clear. But it is by no means certain that the Administration will go along with such a request. This still must be thrashed out.

The national election a year from now looms large in any consideration of a supplemental request. It also must be taken into account when viewing the chances of a Fiscal 1965 appropriation of $5.6 to $5.8 billion, which the space agency feels is necessary to keep its programs moving on schedule.

Given the considerable evident public uncertainty about benefits of the space program, Congressmen may find the multibillion-dollar space budget an albatross they would prefer to be without. A demonstration to economy-minded voters of vigorous budget-slashing may be difficult to resist.

This temptation will be heightened by the fact that, once again in 1964, the dramatic achievements of 1962 will be missing. It is true that next year will offer a much more crowded launch schedule and that unmanned tests of *Saturn, Gemini* and *Apollo* systems will signal the approach of truly impressive space achievements. But the only manned shot on the schedule is a *Gemini* flight set for December, which is more than likely to slip into 1965.

Thus, Congress again will be confronted with a paucity of manned flights in an election year, when the temptation to wield the budget axe is at its height.

The problem basically is not one for the space agency but for Congress. NASA has set its course with the backing of President Kennedy. If Congress now is in a mood to withdraw its earlier support, particularly for the manned lunar-landing program, it must openly arrive at the decision in full knowledge of, and after full study of, the consequences to Project *Apollo*.

NASA Administrator Webb, in his foreword to this third annual NASA issue of MISSILES AND ROCKETS, sets the cost of delay in current programs at $1 billion a year in additional overhead. This is a high price to pay for the opportunity to slip further behind the Soviets.

The downturn in spending for *Apollo* is in sight. The facilities and hardware for the Moon program must be paid for now if the schedule is to be met. But the budgets of Fiscal 1965 and 1966—which can be anticipated at a requirement of about $5.7 billion each—will mark the peak of *Apollo* spending. If the appropriations request of FY '65 is met, it is even possible that the FY '66 budget can drop toward the $5-billion mark.

NASA has undertaken extensive studies of programs which it may want to fund beyond *Apollo*, as evidenced in the pages of this special issue. To carry these into development, additional large expenditures will be necessary. Congress can exercise its discretion as to whether the space agency should proceed with such projects. We anticipate that, with election problems behind it and impressive achievements in manned exploration of space by NASA and the industry before it, Congress will give strong continued support to the space effort.

BUT THIS MORE FAVORABLE climate still lies some distance ahead. For now, NASA must prepare for further financial difficulties. It must be prepared to postpone, or even sacrifice, some of the programs described in this issue if this is necessary to keep *Apollo* on schedule.

The re-programming restrictions imposed by Congress are a handicap when considered in this light. But there is no reason the space agency should not be prepared to present on the Hill a re-programming to keep *Apollo* moving at its fastest pace if Congressional economy moves threaten its schedule. It is understandable why the space agency would be reluctant to discuss such a possibility at this time, when the budget still is under consideration. But if worse comes to worst, we would prefer to see postponement of some of the scientific satellite programs rather than a delay in *Apollo*.

William J. Coughlin

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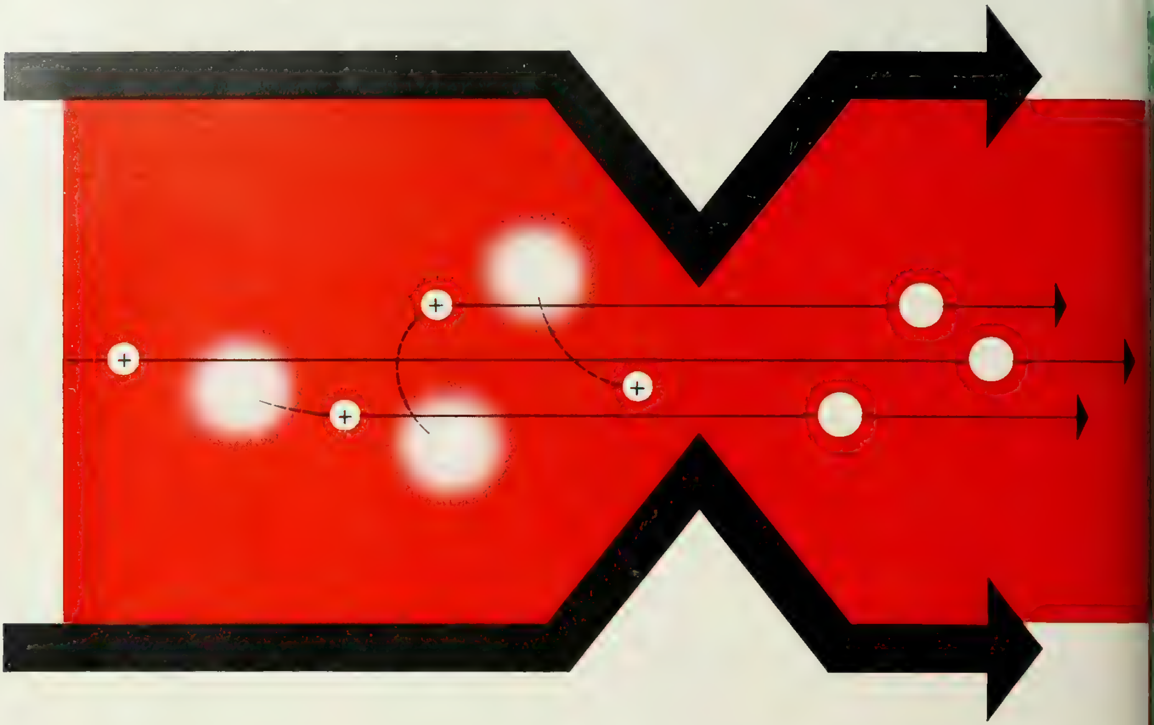

PHYSICS: ADVANCING THE STATE OF THE ART

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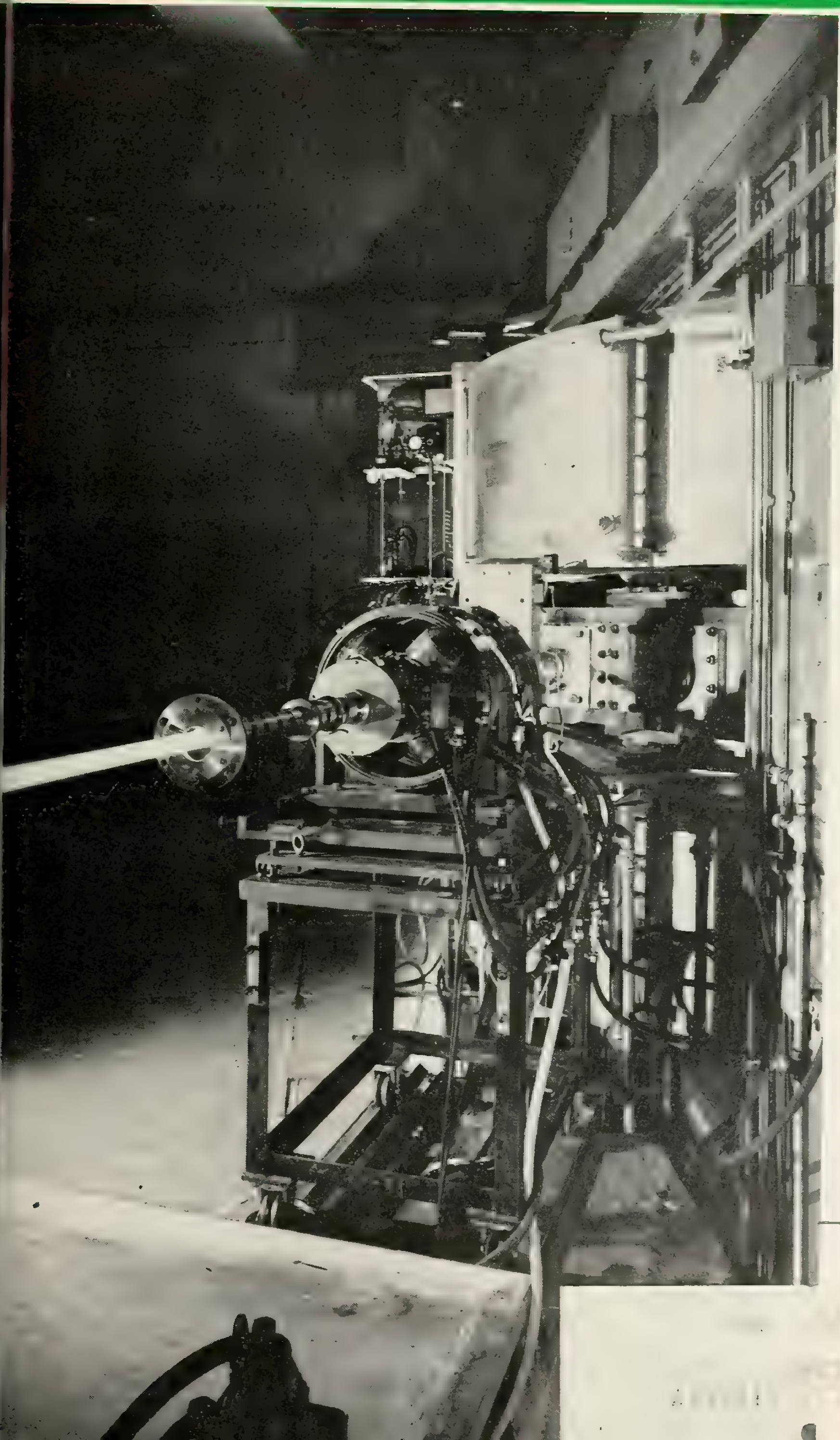


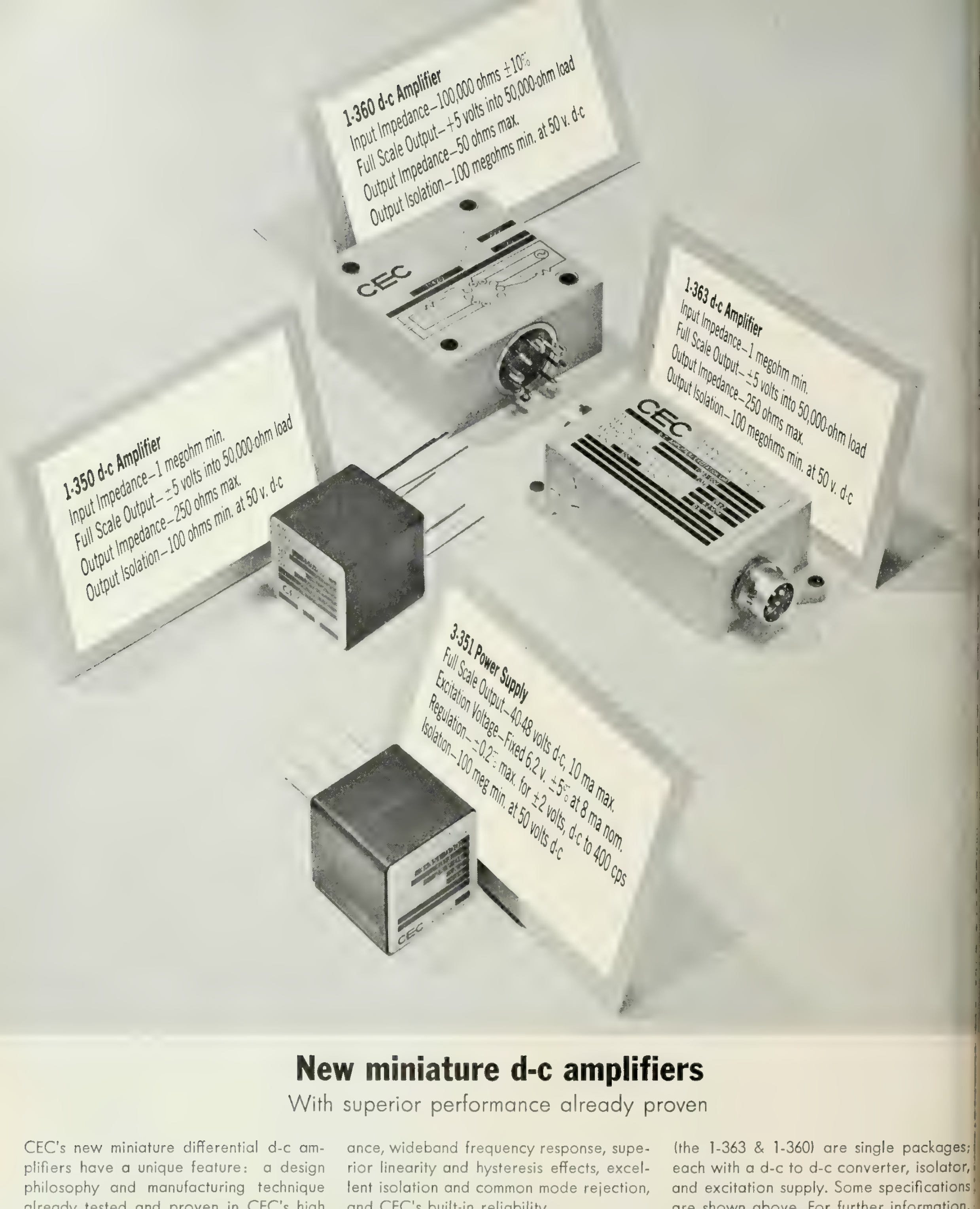
Johnson Will Press U.S. Space Program

Military Space Role May Grow

Part II: Profile Of an Industry

Aerojet's New Florida Plant

Lewis Center Cyclotron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THE COVER

Cyclotron at NASA's Lewis Research Center, Cleveland, tests how radiation in visible light beam damages materials. Test crystal is ordinary salt, which yellows and ultimately turns brown under intense bombardment. Studies will subject metals to radiation to determine nature and extent of structural changes.

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TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

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letters

Saturn V Test Stands

To the Editor:

On the second page of your Sept. 30 article, "First Mississippi Facility Test Set for Mid-'65" (p. 38) there is an error which might create erroneous conclusions.

The illustrations and descriptions referencing two of the *Saturn V* Stage Static Firing Test Stands are incorrect. The S-II Stage utilizes the single-position test stand pictured, whereas the S-IC Stage occupies the two-position test stand. I believe you will find that your otherwise excellent article has the above test-stand descriptions reversed.

L. A. Jared, Chief
S-II Static Firing Operations
Los Alamitos, Calif.

Apollo and Saturn I

To the Editor:

Your apparent acceptance without constructive criticism of NASA's decision to cancel *Apollo-Saturn I* flights (M/R, Nov. 4, p. 15) was disappointing. Now, with Premier Khrushchev's admitting a Soviet Moon program, with their uncanny ability to concentrate effort and with budget opposition persisting, I would think our space agency would do everything possible to streamline *Apollo* and keep it on schedule, not delay it.

You stated that astronauts would gain the same flight experience in *Gemini*. I do not agree; *Gemini* is designed differently, it will handle differently, and *Apollo* pilots should not be stuck with the confusing and delaying job of learning to fly both *Gemini* and *Apollo*. *Gemini* scheduling should not hinder *Apollo* progress.

The questionable part is the purpose behind *Apollo-Saturn IB* flights, which I understand include an entire LEM. Probably the only part of LEM necessary for these flights is the ascent stage, at about 5,000 lbs., to simulate the lunar orbit rendezvous condition. By including a service module scaled down in weight to 7,000 lbs., plus the 10,000-lb. command module, it totals 22,000 lbs., the orbital payload of *Saturn I*. Therefore, the same results planned for *Saturn IB* can be achieved with *Saturn I*, only sooner. In orbit, the command and service modules would invert, dock onto the LEM ascent stage, then the S-IV second stage of *Saturn I* would jettison. Two men would enter LEM, separate except for a safety line, and redock; then separate, go into a different orbit, rendezvous and redock.

You also stated that the cancellation decision was based partially on recent successful ground tests of LH_2 stages. This was the S-IV stage, and NASA could stick to this stage for *Apollo* training without delays until *Saturn V* is ready for lunar orbit missions.

All-up testing was well emphasized, but *Saturn* R&D flights 6 and 7 perhaps should have *Apollo* command modules with dummy cabins and live automatic recovery systems. If these are successful, the first manned three-unit training flight

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hould follow soon afterwards.

NASA could save *Saturn IB* for future lanet probes or save its S-IVB stages for *Saturn V;* and *Gemini* flights could be decreased—or better yet, give *Gemini* to the Air Force. If they would strip down a ervice module (even if it cost the same as tandard one) and rush completion of a LEM ascent stage, the U.S. could fly *Apollo* by late 1964, providing early experience at long endurance, docking and endezvous. This would put *Apollo* ahead of schedule, impress the world, renew Congressional and public confidence in our pace program. Or am I too impatient and misinformed?

John B. Stevenson
Wickliffe, Ohio

Profile, Part II

To the Editor:

In your Oct. 28 issue, you had an article entitled "Profile of An Industry," identified as Part 1 of a series. I found this article extremely interesting, and was particularly sorry not to see the subsequent portions in the next issues of the magazine.

I wonder if you could tell me when you will be publishing subsequent portions of this article? I should like to be sure that obtain copies of them and see those articular issues.

Robert D. Peck, President
Controlled Environment, Inc.
Needham, Mass.

Part II starts on page 24 of this issue.—Ed.

Momentum and Asteroids

To the Editor:

The subject of controversy in the discussion of angular momentum in the Letters columns of the Oct. 14, 21 and 28 M/R would seem to be the difference between angular velocity and linear velocity, as I shall attempt to show. Angular momentum equals moment of inertia times angular velocity. Moment of inertia equals the square of the radius times the mass. Therefore, the angular momentum equals the mass times the square of the radius times the angular velocity. However, the angular velocity equals the linear velocity divided by the radius. Substituting, the angular momentum equals the mass times the square of the radius times the linear velocity all divided by the radius or mass times radius times linear velocity.

This year Academic Press published another book on the Moon in addition to those mentioned in your Book Reviews column of Oct. 28 (p. 50). It is "Technology of Lunar Exploration," edited by Clifford I. Cummings and Harold R. Lawrence of JPL. Its 989 pages consist of technical papers presented before the American Rocket Society Lunar Missions Meeting held at Cleveland on July 17-19, 1962. The price is $10.25 to all AIAA members and $13.75 to non-members.

Premier Khrushchev's statement (later amended) that the Soviet Union is not in the race to put the first man on the Moon could cause a great deal of speculation as to what the Russians might do as a substitute. In the March, 1963 *Astronautics and Aerospace Engineering,* Published by the AIAA, there is an article, "Capturing the Asteroid," by Dandridge M. Cole of GE Missile and Space Division. It says that the easiest extraterrestrial bodies to visit are not the near planets or the Moon but the close-approaching asteroids! Asteroid landing and return is about as difficult as one-way Mars or Venus flights and Mars or Venus flyby flights, according to the article. Asteroid landings and returns would be easier than Moon landing and much easier that Moon landing and return. . . .

If the Russians have picked this as an alternative to putting a man on the Moon, they have made a choice that we cannot afford to ignore. . . .

D. W. Johnston
Washington, D.C.

M/R published a similar article by Mr. Cole earlier this year ("Asteroids Stir Growing Interest," M/R, Feb. 25, p. 43). —Ed.

Angular Velocity

To the Editor:

Perhaps the success of Mr. Ecklin's invention will be assured, and his faith in physics texts restored, by recognizing that the angular velocity of a particle is equal to the velocity divided by the distance to the instantaneous center, and that substitution of angular velocity for velocity in the expression for angular momentum is in violation of something or other. What to do about the National Academy of Sciences is his problem.

T. B. Delchamps
Mountain Lakes, N.J.

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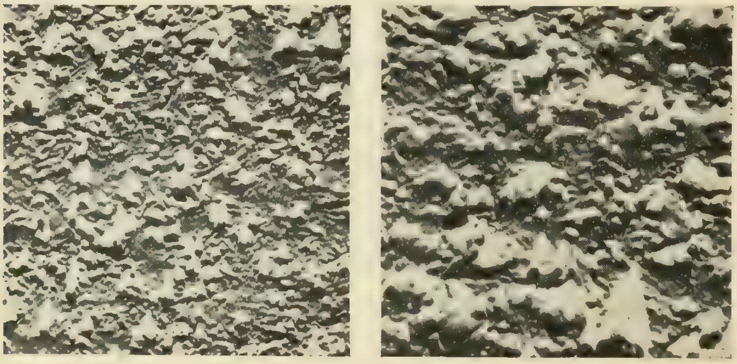

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The Countdown

WASHINGTON

Johnson May Renew Soviet Invitation

President Johnson may approve for inclusion in a United Nations speech by Adlai Stevenson a reaffirmation of the late President Kennedy's proposal for U.S.-Soviet cooperation in a manned lunar landing program. If this is done, Washington sources report, it will be in the same limited form of cooperation favored by President Kennedy.

Manned Space Station May Get Boost

Space project most likely to get a more favorable hearing as a result of the change in the Presidency is the *Manned Orbital Development Station*. President Johnson is believed to be a firm advocate of military space activity, and the Air Force has been pressing hard for this program. But don't look for any major funding in the Fiscal 1965 budgets. Those already are firmed up.

Saturn Launch Set for Mid-December

Earliest date for the *Saturn V* launch is December 12. The flight will put the heaviest payload into orbit to date, if all goes well. Payload weight of 38,000 lbs. will include the *Saturn* S-IV second stage, which will not be ejected.

Boston Is Still Best Bet for Center

There's been no change in the viewpoint of top NASA officials that the best location for the proposed electronics research center is in Boston, Mass., the late President Kennedy's hometown. Studies now being made are not likely to change the agency's first determination that the center's requirements—available engineers, electronics industry and educational institutions nearby—are best filled by the New England, California and New York areas. Nor are they expected to change the decision that, of these, New England is the best bet. Final area selection will be submitted to Congress in January.

Big Space Station Is Favored

Economics may end the argument about the proper sizing of a manned space station. Industry sources carrying out funded studies of the problem predict that small stations may be uneconomic. "Studies show it won't cost significantly more to have a larger station of perhaps 36 men and that, in fact, too small a station (four to six men) wouldn't make economic sense," one spokesmen says. Possible compromise: an expandable station consisting of four-man modules that can be launched separately.

No Early Changes Foreseen in Cabinet

Don't expect any quick changes in Cabinet posts of significance to the missile/space industry as a result of the change in Presidency. But there may be some rapid shifts in second-level posts in the Administration. President Johnson may move his men swiftly into these positions. Men to watch: Army Secretary Cyrus Vance, Pentagon planner Solis Horowitz, Navy assistant secretary Kenneth BeLieu, Johnson administrative assistant Walter Jenkins and press chief George Reedy, *Washington Post* vice president and general counsel Gerald Siegel, U.S. Park Service press chief Charles Boatner, speech writer Horace Busby and Peace Corps deputy director William Moyers.

NASA Fills Top Offices in Manned Flight

John Disher, formerly head of the *Apollo* Spacecraft Office, has been named to direct *Apollo* test operations in the Office of Manned Space Flight. Leroy E. Day will head the *Gemini* test office. Director of *Gemini* program control will be Dick Henry. Eldon Hall will run the *Gemini* systems engineering office.

INDUSTRY

RCA Gets Merritt Island Contract

RCA Service Co. has been selected for a $4-million contract to provide a technical communications system in NASA's Merritt Island Launch Area (MILA). Cost-plus-incentive-fee award calls for the firm to supply telephone equipment for critical operational buildings and areas. Fourteen companies submitted bids.

How Do Flies Smell? Not Bad

How flies smell things is being investigated by Aeronutronic Division of Philco under an ARPA (Advanced Research Projects Agency) contract. A fly detects traces of chemicals faster and at lower concentrations than does a gas chromatograph—despite the extremely small size of its sensors.

Westinghouse Reorganizes Space Center

Westinghouse Electric Corp. has reorganized its Defense and Space Center in Baltimore. The center's four divisions now are under vice presidents: N.V. Petrou, aerospace division; James M. Beggs, surface division; John H. Clotworthy, underseas division; Albert M. Bethel, defense and space systems operation.

R&D Expenditures May Reach $20 Billion

Battelle Memorial Institute predicts that the nation's total research and development expenditures will reach $20 billion next year, an increase of $1.7 billion from this year. Government spending will account for $1.1 billion of the increase. The Institute breaks down 1964 spending this way: government, $13.9 billion; industry, $5.6 billion, academic and non-profit institutions, $500 million.

INTERNATIONAL

British Study Airborne Launches

Launching of an Earth satellite from the back of a high-altitude jet aircraft is under study by the British government and a number of private firms. The recoverable-booster concept is being investigated at the Royal Aircraft Establishment at Farnborough and Bedford. Private firms carrying out studies include Hawker Siddeley, British Aircraft Corp., Bristol Siddeley Engines and Rolls Royce.

The Missile/Space Week

M-2 Pilots Gets Briefing

PROJECT PILOT Milton Thompson explains instruments of NASA's M-2 lifting body vehicle to three pilots soon to make their first flights in the craft: AF Col. Charles Yeager, commandant of Edwards' Aerospace Research Pilots' School, Bruce Peterson and Donald Mallick, NASA.

STL Gets Surveyor Contract

TRW Space Technology Laboratories has received a $645,000 contract for development and testing of an improved *Surveyor* engine.

The fixed-fee award was made by NASA's Jet Propulsion Laboratory.

The new variable-thrust, liquid-propellant engine is designated the alternate landing and mid-course guidance engine for *Surveyor.*

The engine's development is the second phase of a $345,000 contract awarded STL in early 1963.

During first phase development, the duty-cycle requirements met included a 330-sec. firing with two start-stop actions. A servo actuator was successfully operated, using engine propellant rather than hydraulic oil as the working fluid.

The new contract calls for thrust variation between 20 and 180 lbs. STL says that previous tests have shown the high controllability of an engine using a variable-area injector.

Demonstrations have also proved that an uncooled ablative thrust chamber can withstand the duty cycle dictated by the mid-course and landing maneuvers of the soft-landing *Surveyor.*

Shots of the Week

An *Interplanetary Monitoring Probe (IMP)* satellite launched Nov. 26 from Cape Canaveral apparently was proceeding toward its assigned orbit late last week.

NASA officials said the launch and first phases of the shot had gone flawlessly. The 140-lb. probe, boosted by a Douglas *Delta,* will study solar winds.

IMP should reach an apogee of 173,000 miles Dec. 3, and have a perigee of about 125 miles. All stages of the *Delta* worked smoothly, according to NASA.

Signals from the satellite, which is designed to orbit for a year, "were being received better (from space) than they were when it was sitting on the launch pad," said one space agency spokesman.

- NASA also launched two rockets from Wallops Island, Va., Nov. 26.

A *Nike-Apache* carried instruments to an altitude of 103 mi. to measure the change of density an composition of the atmosphere wit altitude.

- Shortly later the space agenc sent aloft a *Nike-Cajin* with thre 26-in. aluminum-coated balloons. Th balloons were ejected at differen levels to gather information on win velocity.
- India fired a *Nike-Apache* rocke Nov. 21 from that country's Thumb Rocket Range. It was the first firin conducted by India and emitted sodium vapor clouds at high altitud for weather studies.

Franco-American About Face

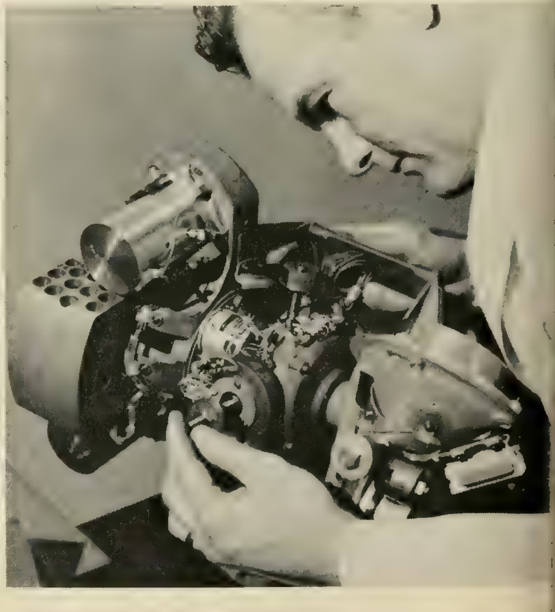
After two successful launches o French payloads atop NASA boosters, the U.S. plans to send a payloa aloft with a French rocket.

The program is under terms o a memorandum of understanding between officials of NASA and France' Centre National d'Etudes Spatiale (CNES) signed Feb. 18. The agreement calls for the launching of another French satellite by an American *Scout* booster later. No exchang of funds between the two countrie is involved.

The 22-lb. American payload wil consist of instruments to measur ion movement and electron temperatures at an altitude of 500 mi. an

Minuteman Stable Platform Shown

FIRST PHOTO of Minuteman missile's stable platform is shown here. The unit provides a "level" reference point during the powered portion of the ICBM's 25-min., 6,300-mi. flight, and is undergoing final tests at Sperry Gyroscope Co,. Great Neck, N.Y.



will be carried aboard a French *Centaure* rocket from Colomb-Bechar, Algeria, in early February.

The attempt will not be the first in which an American payload has been carried aloft by a foreign booster. In 1961, American instruments were launched above Australia aboard a British *Skylark* sounding rocket. However, the Anglo-French effort will be the first in which an American experiment will receive a free ride, since the U.S. paid for the British rocket.

Japan Joins Relay I Link

NASA and the Japanese Government successfully conducted communications satellite television tests Nov. 21 between Mojave, Calif., and a station near Tokyo.

The second pass of *Relay I* on Friday, the 22nd, brought to Japan the first visual details of President Kennedy's assassination.

Despite transmitter difficulties, NASA engineers kept the link intact through the weekend and until after the President's funeral. Periodic tests of the system will continue until the anticipated decay of *Relay I* in mid-December.

With the tests, Japan has joined France, West Germany, Italy, the United Kingdom and Brazil in cooperating with the U.S. in communications satellite ground station activity.

Next step in the program with Japan will be the opening of a second Japanese receiving station next summer in preparation for the launch of *Relay II*.

Blast at Rocketdyne

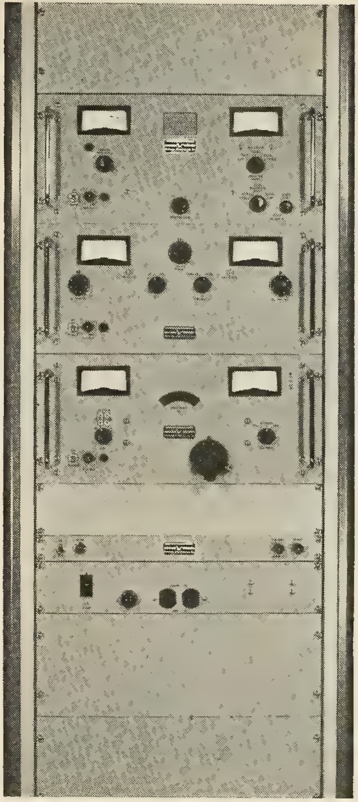
An explosion at North American Aviation's Rocketdyne Div. plant at Canoga Park, Calif., last week killed two workmen and injured two others.

The blast occurred while workers were cleaning a propellant storage tank in a laboratory. Cause was not immediately determined.

ARPA Invites AMOS Bids

Advertisements for construction bids have gone out for the Air Force Advanced Research Projects Agency mid-course optical station on the island of Maui, Hawaii, which will cost an estimated $700,000.

The station will be completed in early 1965 to study mid-course phenomena of ICBM's launched from Vandenberg Air Force Base toward the Kwajalein-Roi-Namur complex.



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SATELLITE DATA
SIMULTANEOUSLY

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- Complete Telemetry Facilities
- Three Channel Monopulse with DC and AC Error Signals
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The ability to track and demodulate IRIG satellite signals *simultaneously* is now possible with the TTR-1 Monopulse Tracking and Telemetry Data Receiver from Defense Electronics, Inc.

Designed for use in advanced aerospace programs, the unit has been refined not only to obtain instant antenna direction for a satellite, but to demodulate and record the signals in conventional telemetry formats.

As a 3-channel tracking receiver in the 215-260 mc band, the TTR-1 has the capability of tracking the RF carrier in a narrow band mode up to the point where good data can be received. Switching to wide band, signals can be demodulated as in other DEI telemetry receivers.

A space saver, the modular TTR-1 employs single-knob tuning with a tuning indicator, choice of two crystals or VFO operations over the complete 215-260 mc band, front-panel switchable IF and video bandwidths. The solid state correlation detectors have excellent noise balance over a bandwidth in excess of 2 mc, allowing use of 1.5 mc IF bandwidths.

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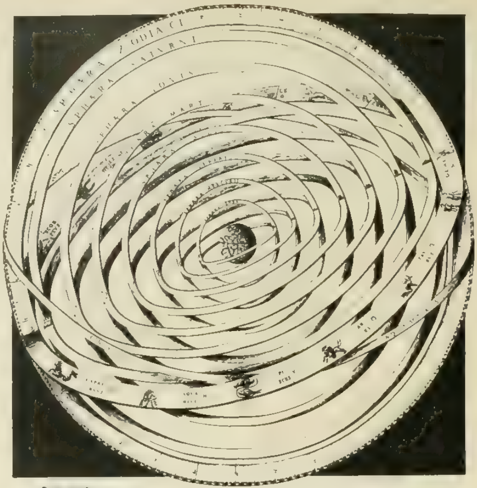

THIS 17th-Century representation of planetary orbits, based on ancient Greek observations, apparently relied more on logic and aesthetics than on fact. Today's demands are for ever-increasing information accuracy, especially about the physical and operational environments of manned space flight.

If *you* understand the environments of space vehicles, and your background includes guidance, navigation, celestial mechanics, flight control, attitude control, or space data processing and communications, you are invited to investigate the many career opportunities available at IBM.

The IBM Space Guidance Center, as guidance system integrator for the Gemini program, is developing the Gemini computer as well as improved docking/retrieving and re-entry techniques for NASA. The Center is also developing the guidance computer and related equipment for the Saturn program. IBM's on-board data processor for the Orbiting Astronomical Observatory is further evidence of the professional level of accomplishment by our space technology scientists and engineers.

Current studies at the IBM Space Guidance Center—in central New York State, bordering on the Finger Lakes vacationland area—include re-entry guidance and control, and space station data management and communications. IBM is an Equal Opportunity Employer.

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ARPA wants to know much more about what happens to missiles in mid-course.

The University of Michigan will spend $5 million for instrumentation. Also involved are the University of Hawaii, on whose property the station will stand, and the University of Arizona on an advisory basis. The station will be available to the University of Hawaii for experiments during down-time.

University Research Defended

NASA's program of awarding basic research to universities was defended last week by Sen. John Sparkman (D-Ala.), who criticized the Senate Appropriations Committee restriction curtailing this activity.

Sparkman said of the program that it has "already demonstrated its great potential contribution to the accomplishment of the NASA mission and the welfare of the country."

The committee said in its report accompanying the Independent Offices Appropriation Bill that because of overlap with other Governmental grant education programs, it questions NASA's $21-28 million program and directed that no new grants be made without specific authorization and appropriation. Sparkman said the language of the report is both "vague and obscure" and could do more damage than good.

"Certainly the committee cannot intend to hamstring NASA in the conduct of one of its most significant activities," Sparkman said.

Lockheed Top Contractor

Lockheed Aircraft Corp. again leads all U.S. firms in the total value of military prime contract awards received in Fiscal Year 1963.

Lockheed received 5.5% of the $25.83 billion total, with $1.42 billion. Boeing was second with $1.35 billion, and North American Aviation, third with $1.06 billion.

Other firms in the top 10 were: General Dynamics, $1.03 billion; General Electric, $1.02 billion; Martin Marietta; American Telephone and Telegraph; United Aircraft; McDonnell Aircraft; and Sperry Rand.

Lockheed also topped a list of 500 firms and organizations in terms of value of research, development, test and engineering contracts received from the Department of Defense in FY '63.

General Dynamics slipped to second place and Martin Marietta rose rom sixth to third.

The 500 contractors included 377 .S. business firms, 119 educational, stitutional or other non-profit intitutions, and four foreign firms. total of 118 of the firms were ategorized as small businesses.

The leading ten contractors and e total amounts of their contract wards were listed as follows: Lockeed—$547,824,000; General Dynams—$519,314,000; Martin Marietta—457,891,000; North American Aviaon—$394,373,000; Boeing—$363,01,000; Western Electric—$273,59,000; General Electric—$255,792,00; Aerojet General—$202,177,000; ouglas—$159,471,000; Sperry Rand -$134,195,000.

Top non-commercial contractor on e FY 1963 list was Aerospace orp., in eighteenth place, with 71,867,000. Massachusetts Institute f Technology was twentieth, Johns opkins University twenty-first, itre Corp. thirty-third, Stanford esearch Institute thirty-ninth, Combia University forty-second and and Corp. forty-fifth.

ILA Support Bids Asked

NASA's Launch Operations Cenr is seeking bids to provide operaons support services for the Merritt land Launch Area.

The contract to be let will cover ch things as general maintenance, ansportation, medical services, serity, fire protection, utilities operaons, supply and office janitorial rvices.

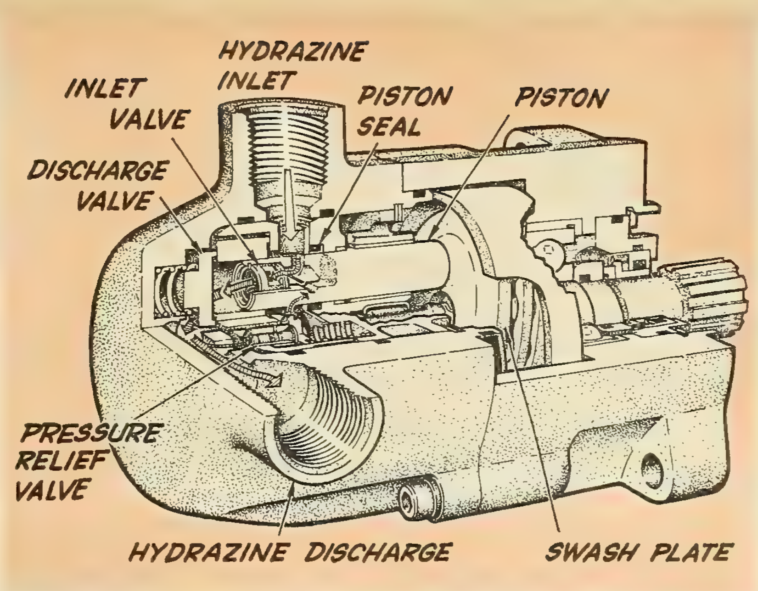
General maintenance, supply and ilities operations will be performed a cost-plus-award-fee basis, while e remainder will be done on a fixede basis.

A total of 98 firms have been inted to submit proposals for the ntract, which will be awarded for e year with an option to renew r two years.

erojet Sales Up

William E. Zisch, President of erojet-General Corp., has told a eeting of the Aerospace Analysts sociation in New York that he exects his company's sales for the cal year ending Nov. 30 will be proximately $700 million. Net earngs are expected to be $17 million, $3.65 a share.

Aerojet's sales last year were arly $605 million, and its earnings re $13.3 million.



PROBLEM: To Develop a Pump to Handle a Low Lubricity, Corrosive, Monopropellant for Space Application

SOLUTION: SUNDSTRAND'S POSITIVE DISPLACEMENT HYDRAZINE PUMP

In order to utilize lighter, low pressure fuel tankage for a storable space power system, Sundstrand engineers faced the problem of developing a fuel boost pump which would handle hydrazine.

Performance requirements were:

FLOW RATE	1 GALLON PER MINUTE
DISCHARGE PRESSURE	1450 PSI
OPERATING SPEED	6000 RPM
LIFE	75 HOURS

MAXIMUM RELIABILITY, MINIMUM SIZE AND WEIGHT

Here's where Sundstrand's long experience in the design of positive displacement pumps and motors paid off. More than 75 hours of operation at 6000 rpm as part of a space power system has proven that the Sundstrand-developed pump performs easily within these specifications. Volumetric efficiency of more than 90% has been demonstrated.

The poor lubricating qualities of hydrazine were side-stepped by eliminating sliding valves, minimizing side loading between piston and cylinder, and exercising extreme care in selection of materials. Lubrication of other moving parts was accomplished by isolating them from the hydrazine.

This basic pump design for low lubricity fluids has many applications in other hard-to-handle fluids. Perhaps you have an application for such a pump, or perhaps you have a fluid supply system problem that Sundstrand engineers can help you solve. For more information on this pump or a description of our varied experience and facilities, write to: Manager, Applications Engineering.

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Under new President . . .

Space Program Support To Grow

New funding for military space could come in FY '66; no early changes in personnel; Johnson's formidable record

by Hal Taylor

PRESIDENT Lyndon B. Johnson is expected to give the U.S. space program even greater support than did the late President John F. Kennedy.

The added support may mean a greater budget for military space projects. Its first manifestation could be assignment of the manned space station to the Air Force.

The increased funding will not be evident until Fiscal 1966. Administration sources report that it is too late to change the Fiscal '65 budgets for the Dept. of Defense and the National Aeronautics and Space Administration because they are practically ready for submission to Congress.

The new Administration will approve the same funding levels previously set by President Kennedy—$5.5 billion or less for NASA, about $1.7 billion for DOD and about $200 million for the Atomic Energy Commission and the Weather Bureau.

President Johnson is not expected—at least for the present—to make any changes in the men directing the nation's space projects. On the military side, he declared in speeches during his vice presidential term that Secretary of Defense Robert S. McNamara is the greatest director of the defense establishment in the history of the country.

PRESIDENT JOHNSON: "Space is . . . the great breakthrough of human knowledge . . . Space is a boon—not a boondoggle."

• **On the team**—A list of current top-level DOD officials reveals that several "Johnson men" are already in key positions.

These include Cyrus Vance, currently secretary of the Army and the man most often mentioned as a likely choice to succeed to the number two Pentagon post on the departure of Deputy Secretary of Defense Roswell Gilpatric. Vance first became part of the Johnson group during his service as special counsel to the then senator's Senate Preparedness Subcommittee.

Kenneth E. Belieu, currently Navy assistant secretary for installations and logistics, was staff director of the subcommittee and is often mentioned as the successor to Vance as Army secretary.

Solis Horowitz, now heading the Pentagon's office of organizational management and planning, also has been very close to Johnson. The new president relied heavily, when he was senator, on Horowitz in matters of national preparedness and party policy.

Some and probably all of these men are destined for roles with even greater responsibility during the Johnson Administration. This probably is particularly true of Horowitz, whose second-level influence in DOD has probably been greater than his title indicates.

As far as the space agency direction is concerned, officials point out that was President Johnson—assigned the sponsibility of selecting the agency a ministrator by President Kennedy 1961—who picked James E. Webb.

Noting this, Rep. Olin Teague (Tex.), chairman of the House Mann Space Flight subcommittee, told M SILES AND ROCKETS "I don't think the will be any change in James Webb's a ministrative position. Both Preside Kennedy and President Johnson agre on his selection."

• **Johnson position**—In assessi President Johnson's position toward t space program, sources close to h pointed out that every major forwa step taken in this area during the K nedy Administration was recommend by the then vice president.

Johnson's support goes back even urther—into the Eisenhower Adminisration years.

In 1958, soon after the launch of *putnik I,* he proposed that the U.S. uild a 1-million-lb.-thrust booster. Laer in the same year, he served as chairnan of the Special Senate Preparedness ubcommittee when it considered legisation to establish the National Aeroautics and Space Administration.

There are unconfirmed reports that e opposed the clause in the legislation hich restricted the space program to eaceful purposes, and agreed to it only hen threatened with a presidential veto.

For the record, however, he made a tatement before the UN Committee on eaceful Uses of Outer Space in Deember, 1958, supporting the clause, hich reads "the Congress hereby delares that it is the policy of the United tates that activities in space should be evoted to peaceful purposes for the enefit of all mankind."

After passage of the Space Act, Presdent Johnson served as the first chairnan of the Senate Space Committee, ne permanent standing committee hich authorizes space agency prorams.

His involvement with the program icreased sharply with his election in 960 to Vice President of the United tates. President Kennedy before the iauguration selected him to head the ation's space program.

In March, 1961, the President orered drafted an amendment to the pace Act which made the Vice Presient chairman of the White House's pace advisory group, the National eronautics and Space Council. Conress voted its approval.

In that same month, Johnson recmmended to Kennedy that a suppleental Fiscal '62 budget be requested start development of larger boosters, icluding the *Saturn I.*

In May of that year, Vice President ohnson recommended—and President ennedy subsequently approved—the ational decision to land a man on the Ioon by the end of the decade.

One NASA official tells a story bout the negotiations leading to the ecision which gives a good insight to e new President's operating methods.

Space agency officials—charged with esenting a manned space flight proam—proposed several alternatives ith differing schedules and costs. Johnn became a little peeved at this. He ld them to decide on one proposal ecause if they didn't take the initiative, obody else would. When the space gency officials returned with the plan r Project *Apollo,* it was approved by ohnson and forwarded to the Presient.

- **Helm for council**—Two major uncertainties remain during the early days of the new Administration. One is the question of the operations of the National Aeronautics and Space Council. Since the office of Vice President is now vacant, there is no permanent chairman of the group. While the law could be amended to name some other official chairman, Johnson probably will wait until after the next election, when the office of Vice President again will be filled.

In the meantime, he probably will take advantage of the clause in the Space Act which permits the President to name members of the council to serve as acting chairman during meetings. The members of the council include the secretaries of State and Defense, the NASA administrator and the chairman of the Atomic Energy Commission.

The absence of a permanent chairman is likely to increase the power of Dr. Edward G. Welsh, the council's executive secretary. Welsh, who has worked closely with Johnson for almost three years, may also be selected for an even more responsible position in the Administration.

Another problem besetting the new president is NASA's push for a Fiscal '64 supplemental appropriation of $250 million. The Budget Bureau reportedly is "lukewarm" to the idea. Other Administration officials have a pessimistic view of the chances for Congressional approval.

- **"The great breakthrough"**—President Johnson's support of the space program was well spelled out in a speech he made in June, 1963. He said that:

"If we as a nation had no competition, if we had no stakes of national prestige, if we had no considerations of national security, if there were no Communist Russia or no Communist China, if we had nothing but our self-respect and our tradition of free scientific inquiry, our effort in space today should differ very little from its present magnitude or its present priorities.

"What we are and what we aspire to be as a nation rests upon the predicate of maintaining peace on Earth. If peace is to be maintained on Earth, free men must acquire the competence to preserve space as a field of peace before it can be made into a new battlefield by tyranny. Were there no other considerations, this alone would require us to do what we are doing in space—and would permit us to do no less.

"We are not reaching for prestige in space—we are reaching for peace. And this is considerably more urgent than many realize or others will yet admit.

"Space is clearly the great breakthrough of human knowledge—for centuries to come. We do not know—and the Soviets do not know—what the stars will tell us. We do know that to default the exploration of the universe of space would surely be as catastrophic in its consequences as if we had defaulted exploration of the universe of the atom. Our superiority in any scientific field will be brief and fading if we do not win and hold competence in this new and decisive realm of discovery.

"Space is a boon—not a boondoggle. We are talking superstition—not sense—when we talk of machines overpowering men. We are selling ourselves short when we show the white feather to nuclear fission.

"We have a long and undistinguished record of America failing to anticipate the promise and potential of each new age of science, invention and discovery. Early in our history, there was an effort to close down the Patent Office on the theory that everything worth inventing had already been invented. Even so far-sighted an American as Woodrow Wilson spent time denouncing the automobile. The steamboat, the locomotive, the airplane all brought prophecies of doom and gloom. We have learned a lesson we surely do not need to be taught again." ■

McNamara Seen Remaining for At Least One Year

PENTAGON SOURCES predict that Robert S. McNamara will stay on as defense secretary at least until after the presidential election next year.

Among the jobs McNamara would like to complete, the sources said, are the trend in incentive contracting and the fee-based-on-performance contract concept, the Navy/Bureau of Weapons reorganizations to improve efficiency, settlement of the military space dilemma, and further increasing the capability of U.S. forces for so-called limited wars.

The sources added that the Secretary and President Johnson have had a good working relationship during the Kennedy Administration, and that there is no reason why it should not continue.

They also indicated that there will be no changes in the Fiscal 1965 DOD budget or any change in the fundamental space and ICBM posture of the department because of the change in Administrations.

Role of Military in Space Could Be Expanded Under President Johnsor

Step-up actually was initiated under Kennedy; Senate, House space backers confident; GOP promises to give LBJ 'every break'

by Heather M. David

THE MILITARY may begin to get an increased role in space—but not solely because of a change in Presidents.

A number of people have conjectured that President Lyndon B. Johnson disagreed with President Kennedy in limiting the Defense Department's participation in the manned space program and thus will initiate changes. However, more closely informed officials say there was no disagreement.

Rep. Olin Teague (D-Tex.), chairman of the House Manned Spaceflight Committee, indicated that some sort of decision to emphasize the security aspects had already been made before President Kennedy's assassination in Texas. "Considerable discussion has taken place in recent months," he said, "and a lot was beginning to be done."

Teague had accompanied the President on his trip to Cape Canaveral and Texas space centers, and had discussed the space question with him not an hour before his Dallas stop.

President Kennedy is reported to have mentioned the *Saturn* booster project with a great deal of pleasure, and had suggested to the space committee member that the House Science and Astronautics group accompany him to the Cape to watch it launched.

The decisions on enlarging the military's role were coming anyway, Teague said. He said the importance of space military navigation, surveillance and weather observation and the ability to identify unknown or hostile satellites in space were being recognized as increasingly important. However, there was no word yet on a manned military orbital space station.

• **Confidence felt**—All Congressional leaders who particularly follow the space program expressed the thought that the new President will advocate a strong space program.

Sen. Clinton P. Anderson (D-N.M.), chairman of the Senate Astronautics and Space Sciences Committee, summed up the feeling of many when he said "Space has a real good friend in the White House."

Anderson pointed to Johnson's interest in the space program since he worked in drawing up the framework for NASA, in passing the Space Act in the Senate and as chairman of the Space Committee and the Space Council. "I think he will be a strong advocate of a very active program," Anderson said. Rep. George P. Miller (D-Calif), chairman of the House Space Committee, echoed this sentiment in almost the same words.

The Senate Space Committee chairman also ventured that Johnson probably will "insist on a high degree of cooperation between NASA and the Department of Defense."

Other Congressmen indicated they felt that President Johnson would make a strong fight in the Congress to stop space budget-cutting. His experience in the Senate and knowledge of the attitudes of the individual members would aid him in this, they said.

• **Republican feeling**—The House Republican Space Task Force, which has many times criticized the lack of a strong military space role, expressed confidence in Johnson's judgment on this score. "Without trying to conjecture or compare," Rep. Charles S. Gubser (R-Calif.) said, "We know that he is probably the most knowledgeable person on space today, and that he is close to military people as well."

The Space Task Group on Thursday, Nov. 21, had issued a strong statement criticizing several aspects of the space program:

—It recommended emphasis on missions of both NASA and DOD, and the enactment of legislation to this end if necessary.

—It asked an affirmation that no "military space gap" would be allowe to develop, regardless of the currer Soviet "peace offensive."

—It criticized the fact that 70% c the nation's R&D scientists and eng neers are working on government spac defense projects. The Republicans sai that this figure is reversed in natior competing with us.

—It advocated a professional sta of trained people responsible to th House and Senate Space committees t continually spot-check the trouble poin of the NASA program. It said "the usu method of (Congressional) watch dogging over NASA funds is n enough."

—It recommended closing of th "one-way street" in which the Sovi Union would be the beneficiary of th fruits of U.S. technology in "join space ventures.

Gubser said that the positions a still valid, and that copies have gor out to NASA and DOD. However, h said "we're not going to start carpin on this now. We'll give him (Preside Johnson) every break in the books."

• **Joint space venture**—While it not yet known whether President Joh son will repeat President Kennedy's i vitation to the Soviets to conduct a joi lunar landing, the new President fac Congressional restrictions and a goo deal of opposition. Both House an Senate appropriation bills for NAS include clauses prohibiting such a ve ture without permission from Congres

• **Kennedy memorial**—House Spa Committee Chairman Miller told M/ that he had thought quite a bit abo designating a fitting memorial to th late President in the space field. H mentioned the proposed NASA ele tronics center. "Something should done to commemorate him and all has done," he said.

Teague also told M/R that he fe a Kennedy Electronics Center would a fitting memorial.

UN committee to act . . .

Space Law Proposal Moves Forward

PRESIDENT JOHNSON has in-ormed Ambassador to the United Na-ions Adlai E. Stevenson that the U.S. vill continue to work through the U.N. or peaceful development of space. But he road ahead is full of uncertainties.

Next step in the long battle to gain n initial agreement on legal principles overning outer space activities will be n the Political and Security Committee f the UN General Assembly.

Members of the UN Committee on he Peaceful Uses of Outer Space, rather han approve the recently submitted .S.-Soviet draft declaration (see below), decided unanimously the morning of Nov. 22 to first submit the draft to the special assemblies committee before it goes before the entire General Assembly.

The draft is the first item on the Political Committee agenda, and activities were expected to get under way late last week or early this week. In general, most members of the committee saw the draft as realistically representing "the maximum area of agreement possible at this time."

There are some reservations among committee members, most of which involve the "peaceful purposes only" issue, and one ominous cloud hangs over the committee—that created by the United Arab Republic delegation. Reserving comment until the end of the committee discussion last week, the UAR representative said that his "silence should not be regarded as acquiescence to the report, but as a full reservation."

The UAR delegate would not elaborate in the Peaceful Uses of Outer Space Committee, remarking that he would make his position clear in the General Assembly. ■

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ext of U.S.-USSR Draft in United Nations on Peaceful Uses of Space

HE GENERAL ASSEMBLY:

Inspired by the great prospects opening p before mankind as a result of man's en-ry into outer space,

Recognizing the common interest of all ankind in the progress of the exploration nd use of outer space for peaceful pur-oses,

Believing that the exploration and use f outer space should be for the betterment f mankind and for the benefit of states ir-espective of their degree of economic or cientific development,

Desiring to contribute to broad interna-onal cooperation in the scientific as well s in the legal aspects of exploration and se of outer space for peaceful purposes,

Believing that such cooperation will ontribute to the development of mutual nderstanding and to the strengthening of iendly relations between nations and peo-les,

Recalling General Assembly Resolution 10 (II), which condemned propaganda esigned or likely to provoke or encourage ny threat to the peace, breach of the peace r act of aggression, and considering that e aforementioned resolution is applicable o outer space,

Taking into consideration General As-embly Resolutions 1721 (XVI) and 1802 XVII), approved unanimously by the ates members of the United Nations,

Solemnly declares that in the explora-on and use of outer space states should e guided by the following principles:

1. The exploration and use of outer ace shall be carried on for the benefit nd in the bodies are free for exploration nd us by all states on a basis of equality nd in accordance with international law.

2. Outer space and celestial seas. Astronauts who make such a landing shall be safely and promptly returned to the state of registry of their space vehicle.

3. Outer space and celestial bodies are not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

4. The activities of states in the exploration and use of outer space shall be carried on in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.

5. States bear international responsibility for national activities in outer space, whether carried on by governmental agencies or by nongovernmental entities, and for assuring that national activities are carried on in conformity with the principles set forth in this declaration. The activities of nongovernmental entites in outer space shall require authorization and continuing supervision by the state concerned. When activities are carried on in outer space by an international organization, responsibility for compliance with the principles set forth in this declaration shall be borne by the international organization and by the states participating in it.

6. In the exploration and use of outer space, states shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space with due regard for the corresponding interests of other states. If a state has reason to believe that an outer space activity or experiment planned by it or its nationals would cause potentially harmful interference with the activities of other states in the peaceful exploration and use of outer space, it shall undertake appropriate international consultations before proceeding with any activity or experiment. A state which has reason to believe that an outer space activity or experiment planned by another state would cause potentially harmful interference with activities in the peaceful exploration and use of outer space may request consultation concerning the activity or experiment.

7. The state on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and any personnel thereon, while in outer space. Ownership of objects launched into outer space and of the component parts, is not affected by their passage through outer space or by their return to Earth. Such objects or component parts found beyond the limits of the state of registry shall be returned to that state, which shall furnish identifying data upon request prior to return.

8. Each state which launches or procures the launching of an object into outer space and each state from whose territory or facility an object is launched, is internationally liable for damage done to a foreign state or its natural or juridical persons by such object or its component parts on the Earth, in air space, or in outer space.

9. States shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress or emergency landing on the territory of a foreign state or on the high seas. Astronauts who make such a landing shall be safely and promptly returned to the state of registry of their space vehicle.

Third thoughts? . . .

Soviets Revert to ICBM Emphasis

by Frank G. McGuire

GENEVA—The Soviet Government apparently has reversed strategy again to put prime defense reliance on ICBM forces after a three-year flirtation with the same conventional-forces concept now followed by the Pentagon.

The switch, carried out with little fanfare, supersedes a 1961 decision to taper off the USSR dependence on rocket forces in favor of a buildup of conventional forces. Signal for the change came in a recent *Izvestia* article signed by Marshal N. Krylov, commander in chief of the Strategic Rocket Forces.

Between the lines of the Marshal's description of the USSR's present strategy, which contained little mention of conventional forces, there were indications of a desire to cut defense costs in favor of allocating greater resources to other portions of the Soviet economy.

Ironically, this turn of events was substantially predicted nearly a year ago by the U.S. Joint Congressional Economic Committee, which said a choice of resource allocations would force the USSR to taper off some defense spending. The Committee, however, said the taper-off would be in other areas (M/R, Jan. 7, 1963, p. 17; Jan. 14, p. 54).

The question now is what U.S. policy will be in the wake of the Soviet move, inasmuch as the Pentagon began its emphasis on conventional forces at about the same time the Soviets did.

• **McNamara speech**—Defense Secretary Robert S. McNamara reported in a recent speech in New York that U.S. ICBM forces are increasing at a great rate. However, he also presented a picture of increasing capabilities in conventional means of warfare.

McNamara's speech deplored exactly the situation which now seems likely to be partially reversed—that of a nuclear-armed U.S. and an adversary with huge ground forces but little nuclear strength. The Defense Secretary criticized the tendency to evaluate U.S. defense needs in terms of the 1949 world in which this country had a nuclear monopoly:

"It was a picture of a Communist Goliath in conventional strength facing a Western David, almost naked of conventional arms but alone possessed of a nuclear sling," he told the Economic Club of New York, "What most needs changing is a picture of ourselves and of the Western alliance as essentially at bay, outmanned and outgunned except for nuclear arms, no longer exclusively ours.

"We should not think of ourselves as forced by limitations of resources to rely upon strategies of desperation and threats of vast mutual destruction, compelled to deal only with the most massive and immediate challenges, letting the lesser ones go by default."

In contrast to this line of thought, it seems that such is exactly the road now being followed by the USSR, in an effort to maintain an adequate defense while also finding tremendous resources to shore up a floundering agriculture system.

According to Marshal Krylov: "The tremendous achievements of our heavy industry have made it possible in a short period to create a powerful base for the production of nuclear weapons in quantities quite sufficient to bridle any aggressor."

This statement followed immediately on the heels of the Marshal's description of the new Soviet reliance on ICBM warheads and his comment that defense resources could now be channeled elsewhere. He downgraded the role of conventional forces without going so far as to *say* they were being downgraded. But he left little doubt as to the revived importance of ICBM's, and the article was seen as an answer to McNamara's speech.

"The strategic rocket forces," the Marshal writes, "have a military capability which makes it possible not only to ensure the lightning destruction of the most important groupings of the adversary, but to crush completely his military-economic potential, to disorganize the state and military administration and to destroy the enemy's strategic means of nuclear attack."

• **Background**—In 1961, Premier Khrushchev and the rest of the Soviet leadership decided that the increased spending and manpower allocations needed for conventional forces was worthwhile, and began taking the edge off public remarks about long-range rocket forces. Some elements of the military resisted the changeover, and a published debate in Soviet militar journals showed the split.

Consequently, a sort of compromis agreement was reached in which bot concepts had a place in overall strateg As nearly as can be determined, th upgrading of conventional forces wa not a Khrushchev idea, but he wen along with it reluctantly. All publi utterances since then have given li service to conventional forces, excep for the latest pronouncement by Krylo which is an obvious retreat from th compromise strategy and a return t Premier Khrushchev's all-ICBM concept.

• **Civilian needs**—The Soviet leade has recently made public demands for 20-billion-ruble program to move th country's chemical industry forwar With this huge outlay it is hoped t modernize the presently-lagging chem cal industry to a level of Wester achievement, with the specific task o turning out more and better fertilize for the lagging agricultural sector o the economy.

This is where the Joint Econom Committee's report was a bit off-bas the investment funds needed will b taken not from ICBM productio ICBM-defense or space flight, but i stead from conventional militar strength.

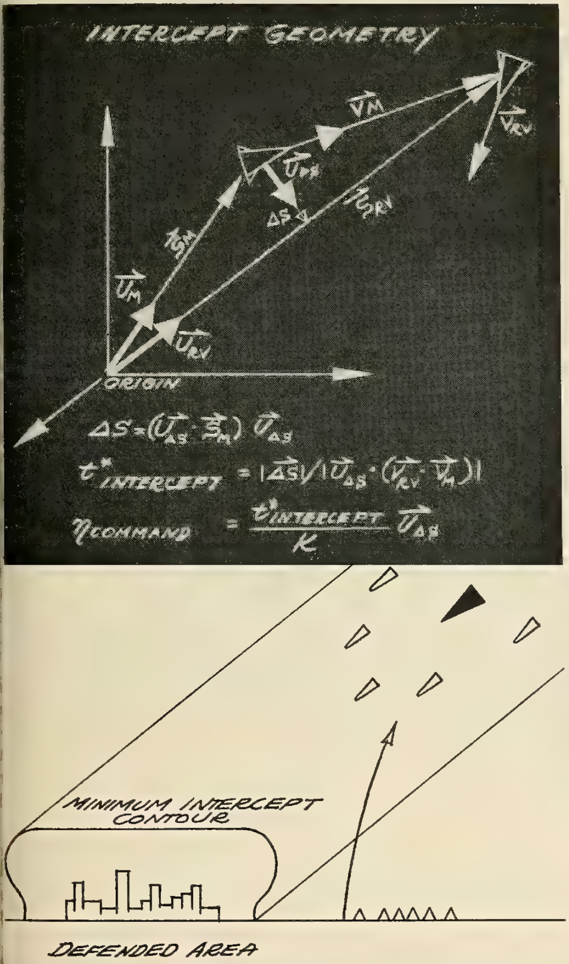
It is a justification of this re-alloc tion which Marshal Krylov presente with his comment on the nuclear wea ons production already achieved b heavy industry.

With a plenum session of the rulin Central Committee coming up on th Kremlin's calendar, it is not yet clea whether Krylov's article is a flat a nouncement of an accomplished polic switch, or merely a stage-setting devic to get the jump on conventional-for advocates expected to fight such change during the plenum session.

A member of the Central Committ who has been looked upon as a co ventional-forces advocate is Frol Ko lov, but he has been absent from h duties since April with an illnes Whether or not his absence was th factor which permitted the strate switch cannot be determined, but un he became ill he was regarded Khrushchev's heir.

ENGINEERS/SCIENTISTS

WORK ON PROBLEMS LIKE THIS...


INTERCEPT GEOMETRY
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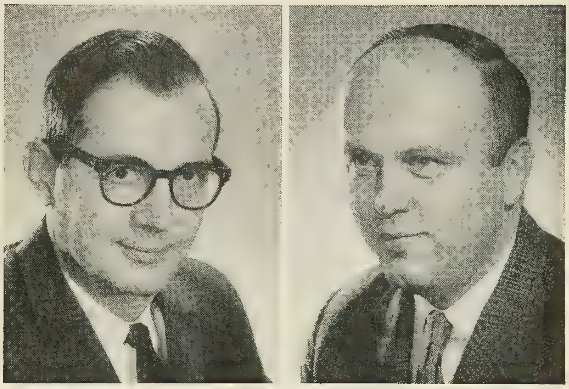
DEFENDED AREA

WITH ASSOCIATES LIKE THESE...



Mr. E. P. Williams (left) is Chief of the Aeromechanics Branch, Advance Missile Technology. He directs efforts in the Flight Mechanics, Aerothermodynamics, Aerodynamics and Nuclear Effects Sections. Mr. Williams was among the Douglas engineers who went with the Rand Corporation when it became independent of Douglas in 1948. He became head of Aerodynamics at Rand and specialized in hypersonic aerodynamics and glide rocket research and engineering.

Mr. J. L. de Grandpre (right) is Douglas Study Director for the USAF Foreign Technology Division, Analysis and Synthesis of Military Space Systems. Previously he was Director of the Advanced Computer Program Development Section within Advance Missile Technology. Earlier, he was engaged in systems analysis and flight simulation work in Canada.

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Navy Studying Control of Weapons Through 'Thinking' of Them

THE OFFICE of Naval Research has contracted with Philco Corp. for research which might lead to control of weapons or other mechanical devices by "thinking about them."

The research, "a study to investigate the feasibility of utilizing electrical potentials on the surface of the skin for the control of functions," is based on the theory that the electrical signals which activate human muscles can be intercepted and extended to control mechanical systems.

While current work is based merely on determining whether these signals are identifiable and consistent among human beings, there are these possible applications:

—Astronauts under heavy g loads could perform functions by mechanical means which otherwise would be impossible.

—Weapons systems could be directed and fired remotely. For instance, a gun mounted on a tank might be so controlled by the man's eyes that it would move as the man looked about, and fire on his direction.

—Remote functions, such as underwater salvage or Moon exploration, could be performed with the advantage of instant reaction time and added flexibility.

—A bio-controlled man-amplifier could be constructed. ONR already is pursuing this line with Cornell Aeronautical Laboratories, on the basis that man might be put into a framework which would provide extra power by mechanical means. For instance, the man might decide to lift a heavy object. The normal impulse which travels from his brain to his arm could be sensed electronically, and used to activate a powering device which would increase his capability greatly.

—Artificial limbs or prosthetic devices. The nerves which lead to missing limbs often are not damaged and still transmit signals—for instance the itching, although missing, toe. A prosthetic device actually powered by these nerves would have far greater flexibility and more precise control than current methods. The Veterans Administration is said to be particularly interested in this application.

Perhaps one of the greatest advantages of such a system would be the immediate reaction time. The time used in activating a weapons system could make a great deal of difference.

- **Raises questions**—Dr. James W. Miller, project officer for the Office of Naval Research, said the Navy is taking a very cautious attitude towards this research. "First," he said, "it must be established that the pattern of stimulation when a man moves his arm is the same every time he does it. Then, we must determine if there is a common factor from person to person."

The first phase of the study is being carried out by the Research Division of the School of Engineering and Science of the New York University, with the cooperation of its Medical School. In this phase, one subject is continuously monitored by electrodes placed on the skin of his arm.

All the signals—which include a great deal of other noise besides the electro-myographic (EMG) potential—are run through an amplifier and filter system. Here the signal is isolated and amplified, then routed to a Philco-2000 computer. The computer processes the signal for a display system called the "perceptron."

The display system will be particularly helpful because the subject learns to recognize what patterns occur when he makes certain movements.

- **An electronics problem**—While the existence of the electrical or bio-signals has been known, it has been very difficult to identify the signal which could be used in a control system because of other electrical activity on the skin. The problem is further complicated by the fact that the signal may vary if the subject is tired or stressed. Experts at Philco Bio-Technology Laboratory at Blue Bell are analyzing the data from the experiments and attempting to solve these problems.

Originally Philco had announced it would begin experimentation with animals, but preliminary data were so good that they have moved into human research. The company now is operating under a six-month contract from ONR. NASA is known to be very interested in the work. ■

SAM Gets New Northrop Simulator

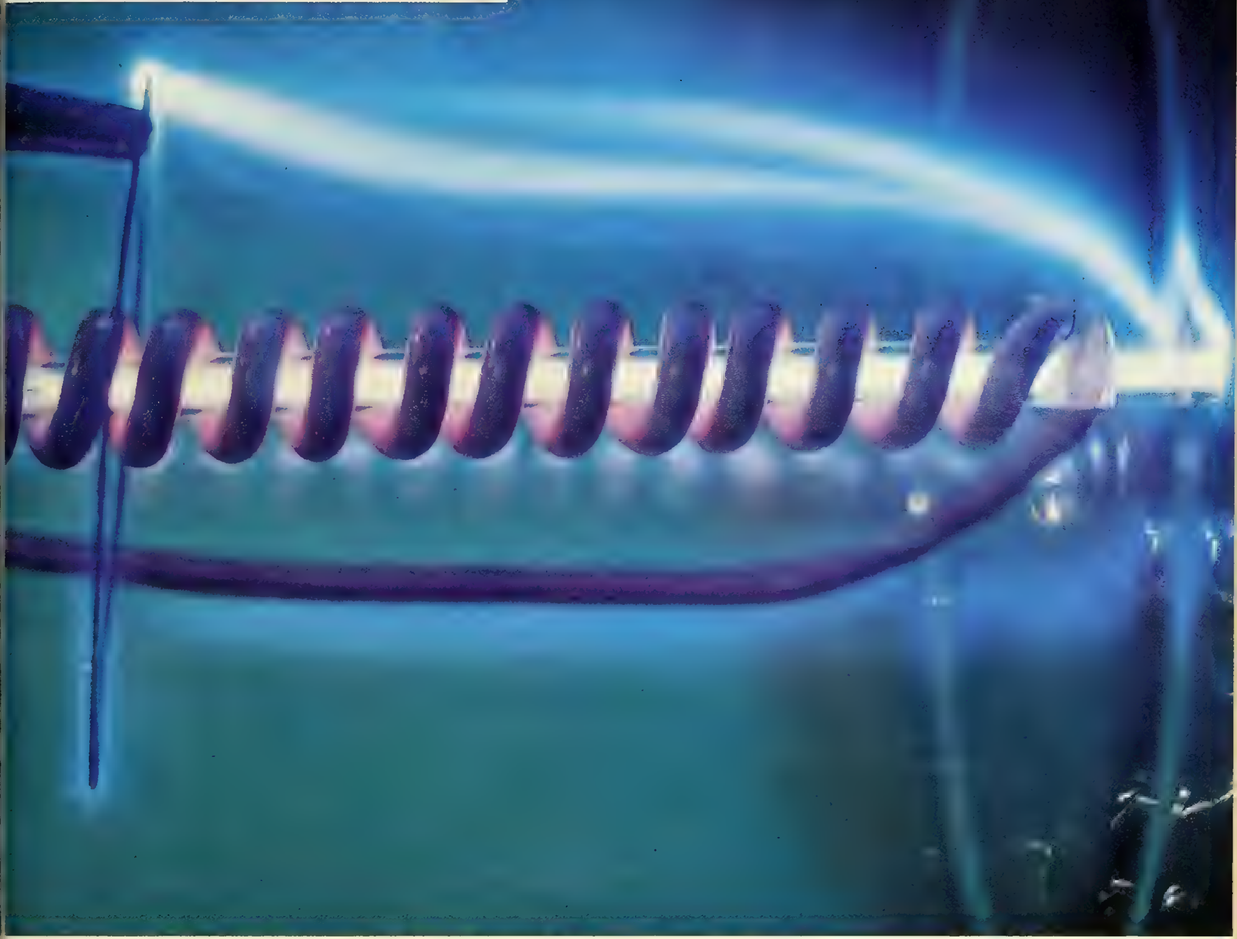
NORTHROP'S Rotational Flight Simulator—one of the most rigorous astronaut training aids yet—is being installed at the USAF School of Aerospace Medicine, Brooks AFB, San Antonio, Tex.

The 10-ft.-dia. chamber floats on a shallow layer of compressed air and can rotate up to 50 rpm in one or a combination of three axes through three hydraulically-powered inertial rings.

The air-conditioned chamber can also be used to study the effects of reduced pressure and stress, since it can go to 18,000-ft. simulated altitude. It is equipped with communication facilities, closed-circuit television, balance and altitude indicators and electronic leads for biomedical monitoring.

Almost any tumbling, spining or complex of movements can be studied on the device. The three-ton sphere is said to be the largest ever floated on air, and is constructed of bonded, non-transparent honeycomb fiberglass.

LICONE NEWS from Dow Corning



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INERT TO OXYGEN, OZONE and many chemicals
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For design manual on Silastic silicone rubber, write Dept. 6224, Engineering Products Division, Dow Corning, Midland, Michigan.

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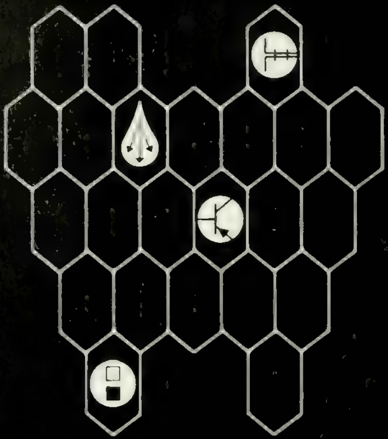

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Technical Countdown

ELECTRONICS

Sylvania Will Minify Laser Modulator

Sylvania Electric Products, Inc., will redesign its in-house developed wideband laser modulator, now measuring 40 in. in length, to produce a new feasibility model having comparable performance, but squeezed into a package only a few inches long. The new low-power modulator, which will be used for research studies of very large capacity communication transmission systems, will be developed for the Aeronautical Systems Division of the Air Force. The $83,000 contract calls for delivery by July, 1964, the company disclosed. As a part of their effort, developers will attempt to extend the modulation bandwidth to beyond 1 gc.

Precise Control Claimed For Big Mount

Fingertip-pressure control to a pointing accuracy of ±2 arc seconds can be achieved with a massive 25-ton, gimballed tracking mount built by Nortronics Division of Northrop Corp. for NASA's Goddard Space Flight Center. Developed as a research tool, the mount will be used initially to support a 3,500-lb. laser telescope system and later for other advanced electro-optical trackers. Riding on hydrostatic bearings, rotating members of the mount are designed to operate both in equatorial and X-Y modes. Control is optional, varying from completely manual to almost fully automatic, developers said.

Two-Frequency Laser Light Source Ordered

A laser light source, capable of emitting signals at either of two fundamental frequencies, will be built by Kollsman Instrument Corp. for the Army's Ballistic Research Laboratory, Aberdeen, Md. The laboratory device will provide extremely uniform light beams of essentially square, 20-μsec.-long pulses for use in interferometric studies of plasma and other shock wave phenomena.

MATERIALS

Two New High-Nickel Alloys from Firth

Firth Sterling, Inc. is marketing two new high-temperature, high-nickel alloys—FS-X-750 and FS-718. The alloys are available in ingots, billets, bars, rod and wire. FS-718 can also be supplied in sheet and plate. Both compositions are produced through the Firth Sterling patented Hopkins process. The flux blanket remelting process results in extremely clean, sound and fine-grained alloys.

Pressure Pulses Double Heat Transfer Rates

Sending pressure pulses through boiling liquids can double heat transfer rates under certain conditions, according to a Purdue University researcher. The key to the increased heat transfer is in collapsing the vapor films that sometimes form between the liquid and surface to be cooled. Such vapor barriers are poor heat conductors. Initial results by Prof. R. J. Schoenhals of the Purdue School of Mechanical Engineering indicate that the route to miniaturization of space cooling systems may have been discovered.

New Crystal Growth to Aid Laser R&D

To assist in the development of high-energy-output lasers, Autonetics Division of North American Aviation will produce cerium-dioxide and magnesium-oxide crystals under a one-year $144,000 contract for the Office of Naval Research. Researchers stated that they will employ the chemical-vapor process for crystal growth as a means for lowering the processing temperature from 3,000° to 1,000° C, as compared with more conventional melting growth methods. This, they claim, will eliminate thermal strains and thus improve crystal quality, and also will permit the growth of very large crystals.

Synthetic W Improves Thermionic Emission

Scientists at Varian Associates have developed an improved emission material by depositing tungsten so that all crystallites are oriented to provide an emitter surface with an unusually uniform work function. Normal tungsten surfaces exhibit a patch effect since the surface is composed of randomly oriented crystallites. Varian experts say the development opens the way for advances in a variety of fields. Tungsten per se is not the material of greatest interest but is only amenable to basic research. The principles can be applied to other electronic materials ranging from superconductors, phosphors and electron tube electrodes to photosensitive surfaces.

PROPULSION

Sea Horse Tested

A 17,000-lb. thrust liquid rocket engine ran sucessfully in a waterborne test in San Francisco Bay under the guidance of engineers from Aerojet-General's Advanced Development Department. Mounted on a special barge, the engine was fired several feet above the water in tests designed to prove out the feasibility of Aerojet's Sea Dragon water launching concept. The engine fired was a pressure-fed unit with an 8-sec. duration. The sea launch concept is an attractive route to the construction, handling and launching of huge space vehicles.

SPACE MEDICINE

Radiation Resistants Show Promise

Douglas Missile and Space Systems' Life Science Section is reporting excellent results in the test of radiation-protectant synthetic steroids resembling sex hormones. Eighty-three percent of a group of white mice who were irradiated with gamma rays survived, compared with 25% in a non-protected control group. The Douglas research is based upon chemicals which stimulate the riticuloendothelial system (RES), the same system which produces red blood cells, antibodies and white cells to combat infection. Further tests are being carried out with high-energy neutrons.

Correction

In the Technical Countdown, Missiles and Rockets, Oct. 28 (p. 31), it was erroneously reported that General Electric's Electric Lamp Glass Dept. had developed a 100% dense alpha alumina ceramic which remains stable at 1,900°C in an alkali-vapor environment during transverse rupture in bending of 45,000 psi. The item should have read 45,000 psi nominal at *room* temperature.

Profile of an Industry: Part II

Maturing Industry Now Takes Long-Range View

by William Beller

THE MISSILE/SPACE INDUSTRY, about to become the largest U.S. industrial employer (M/R, Oct. 28, p. 22), is starting to look at systems development in terms of national welfare instead of immediate company profit.

Profits are not lost from sight, but rather are seen in perspective. It is increasingly appreciated that systems that fill the country's long-term needs will benefit contractors more than systems that are quickly terminated.

For this reason Under Secretary of the Air Force Brockway McMillan has encouraged industry "to look at the problem, to state it as a problem, rather than to state a preconceived solution to some other problem."

Planning does not begin with the statement: "We need a 12,000-mile missile with 4,000 pounds payload," he said. "That's a solution." Planning as the Secretary means it, must first arrive at the statement of the problem: "We need within the first day of the war to prevent such and such military installations from accomplishing their mission."

Then, the Secretary told industry late last month, we can look for and look at alternative solutions, evaluate them as solutions to the stated problem, and inspect them in relation to other elements of basic policy.

- **Missile/space industry matures**—In still another way, DOD is recognizing the missile/space industry as partners on the defense team, not as just a collection of job-shops for the country's weapons systems arsenal. The industry is assumed to be able to take severe losses if it does not perform on R&D contracts, as well as high profits if it does. This is what is involved in the performance records now being kept on every major defense contractor, and in emphasizing incentive-type contracting.

"If it works, we may be able to get government out of the contract manager business," a high Pentagon official told Missiles and Rockets. "If profit can manage a company, then the government doesn't have to."

Since World War II, there has been a shift from heavy preoccupation with production to concentration on R&D weapons systems.

One of the government's goals during World War II was to build 50,000 planes a year. Even during Korea, most defense money went into production contracts, mainly fixed-price ones. In the post-Korea years of the late 1950's, however, the effort turned strongly toward R&D. The number of cost-plus-fixed-fee (CPFF) contracts increased.

The build-up of such contracts started in Fiscal 1955, when they accounted for between 15 and 18% of the total defense procurement budget. By 1960, the CPFF-type contract was at its peak, reaching 39% of the procurement budget of nearly $10 billion.

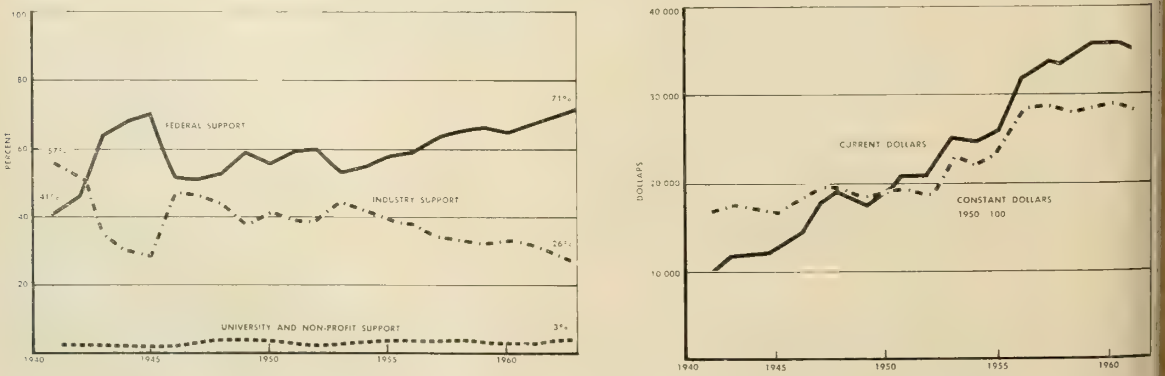
The CPFF contract gave no premium to the contractor for good performance on an R&D contract—nor any penalties for bad performance. Furthermore, there was little or no profit motivation to keep costs down. In some instances, "the longer a contract lasted, the more money the government spent, the better it was for the contractor," a procurement officer said.

This climate led to the government's taking over more and more management control from the contractor. The government looked more than previously into overtime rates, costs, allowable expenses and other details usually the province of company management.

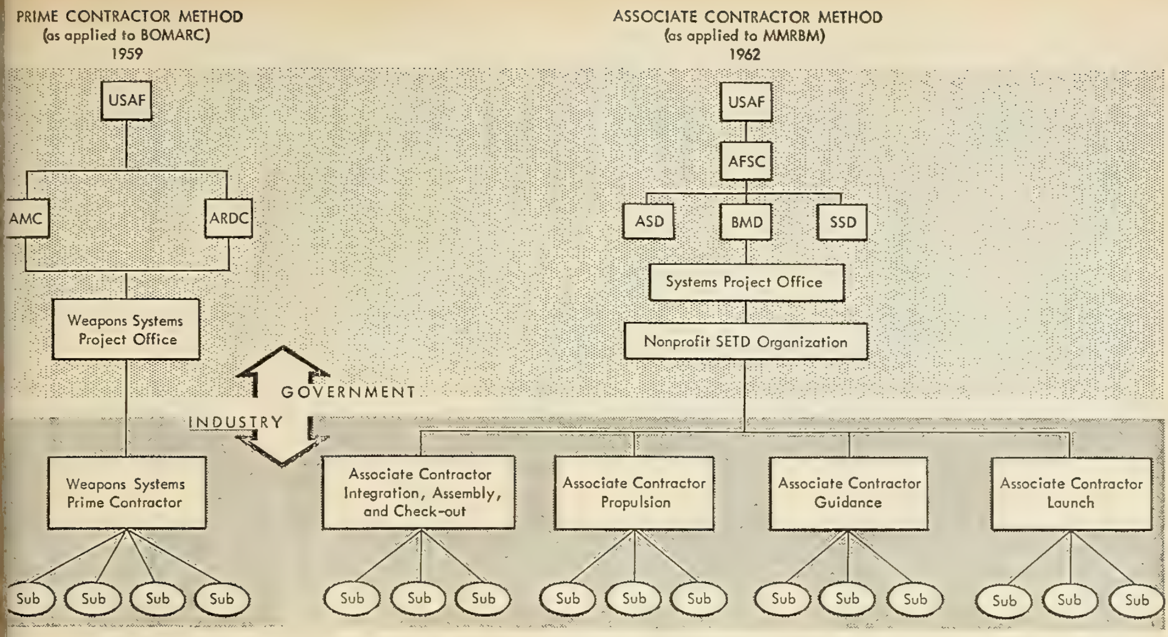
- **The good get profits**—Future R&D contracts will be mostly incentive-type, in NASA as well as in the Defense Dept. Rewards will be for 1) good performance of the weapons or space system developed; 2) timely completion and 3) low cost. The CPFF contract in DOD now accounts for less than 15% of the total procurement budget, and this percentage is declining. "Such a contract may soon become obsolete," a DOD official said, "except in exceptional circumstances." He emphasized that the incentive-type contract is the new way of doing R&D business.

If this continues to be true, then DOD and NASA have hold of a double-edged sword. They themselves will have to be sterling program managers. They will have to define "good" performance and anticipate "timely" completion and "low cost." PERT-time and PERT-cost will be one of the most used tools.

The emphasis will be to do much of the R&D planning, much of the analytical and engineering work in advance so that unknowns are brought to light and new technologies defined. "We will try to put our money on these new technologies before we go into programs based on them," said an Office of the Secretary of Defense (OSD) official. "We'd be foolish at this time, for example, to base an advanced communica-



LEFT: Distribution of sources of funds for R&D. RIGHT: Annual cost of total R&D per scientist-engineer.


PRIME CONTRACTOR METHOD
(as applied to BOMARC)
1959
ASSOCIATE CONTRACTOR METHOD
(as applied to MMRBM)
1962
USAF
AMC
ARDC
Weapons Systems Project Office
GOVERNMENT
INDUSTRY
Weapons Systems Prime Contractor
Sub
USAF
AFSC
ASD
BMD
SSD
Systems Project Office
Nonprofit SETD Organization
Associate Contractor Integration, Assembly, and Check-out
Associate Contractor Propulsion
Associate Contractor Guidance
Associate Contractor Launch
Sub

GLOSSARY

USAF – United States Air Force
AMC – Air Materiel Command
ARDC – Air Research & Development Command
AFSC – Air Force Systems Command
ASD – Aeronautical Systems Division
BMD – Ballistic Missiles Division
SSD – Space Systems Division
SETD – Systems Engineering & Technical Direction

Comparison of Program Management Techniques

ons system on laser technology." He aid that, for DOD, "the process will ield a much better work description nd would specifically tell us how much weapon system would cost, when it ould be ready and what it could do."

With such an approach, a logical end is for captive non-profit corporaons, such as Lincoln Laboratories and AND, to play increasingly important oles in the pre-contract phase of work —that is, in the analytical phase. These rganizations represent government in eir dealings with industry. When a ontract is placed, however, the nonrofits are expected to lose much of eir responsibility. This point was rought out strongly by an OSD spokesan who said that "under a wideinging incentive contract, the conractor must be left to make his own ecisions." He pointed out "that efforts re already under way at OSD with inustry groups looking into what can be one to lessen government controls."

- **Before a contract is let**—OSD is eciding whether to make the programefinition phase of contracting a DOD equirement for major projects. It has ready been used by the Air Force on e *Mobile Medium Range Ballistic issile (MMRBM)* project and earlier y the Navy. Chances are good that ogram definition will become a DOD equirement for all major projects.

Under the system, a contractor does the planning for development before the actual development is committed. In this way, OSD is able to allow considerable leeway on incentive-type contracts, thereby putting increased responsibility on the contractor.

Some critics say that the added phase will also add time to a system's development. This is disputed by an assistant defense secretary who maintains that the time saved in knowing where one is going will avoid much of the formerly-needed improvisions. He claims that OSD considers the program-definition technique as possibly the most significant procurement event in recent years. The only challenger is the contractor-performance-and-evaluation criteria that OSD recently set up.

Asked if the Renegotiation Board might take away as excess profits the earnings gained by a company under an incentive-type contract, the defense official said that the board is "working hand-in-glove with OSD, still looking for profits excessive in terms of performance, but not where performance warrants the profit." The reward factors are said to be similar in the profit equations used by the board and OSD. Furthermore, "the performance reports of our contractors will make a good source of information for the Renegotiation Board," said the OSD secretary.

- **More price competition**—In the field of hardware procurement, other than R&D, the Defense Department is striving to increase the amount of price competition. "Out of every dollar we convert from non-competitive procurement to competitive, we save 25¢," a procurement officer told M/R. This has been proven many times statistically and is the reason the Pentagon is pushing price-competitive procurement.

The pattern: at the beginning of Fiscal Year 1961, 32.9% of DOD's total procurement was on a price-competitive basis. The figure was up to 37.7% at the close of Fiscal 1963. The goal is 39.9% for Fiscal 1965, and "we're running a little ahead of schedule," the procurement officer said.

Much effort is going into developing decision networks to see where price-competitive contracts are logical and where they are not. R&D contracts, for instance, are almost never price-competitive. The procurement officer averred that it would be "bad business" to have them awarded in that fashion. "You don't hire a physician on the basis of lowest bid."

As examples of areas in which price-competitive contracts probably will be issued as a matter of course, he named electronics equipment, standardized weapons, construction, and petroleum production. OSD is trying to find better analytical processes in order to award contracts on a price-competitive basis and to promote adequate planning.

"Steps have to be taken now so that three or four years hence we can buy major components of a given weapons system on a price-competitive basis," said the procurement officer. "It is in this long-range planning field that the most intense work is needed." In the development of *Polaris*, for example, it is possible to draw out components that can be given out on a price-competitive basis. "This technique is being looked for in every single weapons system under development today," he said.

● **If peace comes**—Ford Instrument Co. a few years ago was eager to tell about its ability to make analog computers. The company had a right to be proud of its products which were first used for shipboard fire control during the historic World War I Battle of Jutland, and today, in modern garb, for many missile/space applications.

Highly impressed, the company's advertising agency wrote that "the computers are made as accurately as fine timepieces."

"No!" said Ford Instrument's chief engineer. "Watch parts are mostly stampings, good enough for commercial work, but not where precision is needed." He added that there was a time when his engineers tried to make things cheaper for the non-military market. "Quality had a way of sneaking in, though," he said sadly, "quickly pricing us out of the market."

Like Ford Instrument, most major defense contractors at one time or another have looked to possible commercial lines to make up for the ups and downs of government work. They've tried making and selling such things as aluminum sport boats, prosthetic devices, stainless-steel caskets, aluminum curtain walls, adhesives, plastic wall panels, welding equipment, and gas turbine engines.

Few of the companies could report any great success. Many of them lost the venture capital they had put aside for commercial projects; they retreated to the R&D work needed to make sophisticated government products.

The reasons for the failures were clear. The defense companies were not experienced in designing or selling in the mass market, did not have dealership organizations and—most important—had little real interest in the non-military field. It was just something the companies thought they could get into because of their gift for solving some of the highly complex technical problems of national defense—and should get into for their stockholders.

Today a major missile/space contractor will license his techniques and processes to firms already in the commercial market, and even try to sell scientific equipment. It will be a rare company, though, that will also try to appeal on a large scale to non-government buyers.

Yet some observers accuse the major defense contractors of thinking too small about the non-military market. They suggest that the engineering and scientific talent of these companies could be applied to massive civilian projects in addition to space; examples include salt-water conversion, erosion control, sea farming and mining, air and water pollution control, integration of transportation systems, information systems, power storage and conversion, harbor development, merchant marine improvement, better communications and weather forecasting, nuclear electric power, and water conservation.

The interested parties in many of these instances, though, would still be governments. This perhaps is the proper route for major defense contractors.

● **The emerging profile**—The "aerospace" industry is made up of two broad categories of activities that have increasingly diverged from each other during the past seven years, according to a Stanford Research Institute report.

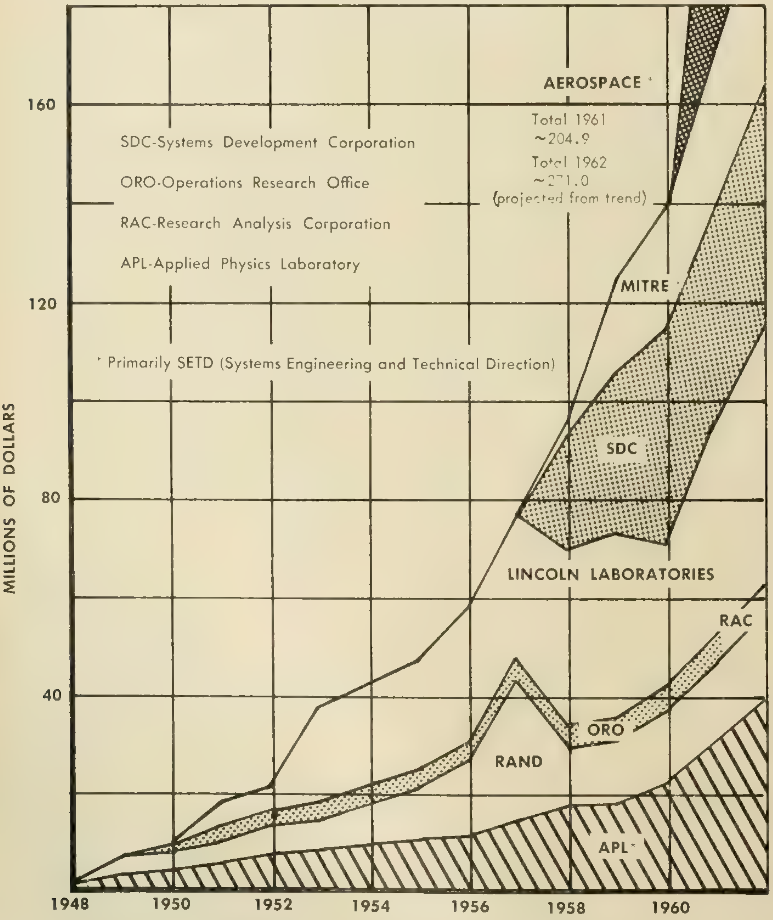
The larger category includes development and production of missiles and space hardware. The other category is centered in the development and production of aircraft.

The report emphasizes the marked difference between the two fields, in terms of functional emphasis, manpower use, floorspace use and level of concern with technical information ever where some companies include both categories in their overall structure.

The report suggests that in a larg and increasing segment of the "aerospace" industry—the missile/space segment—"techniques and devices are no a major part of the solution to th mutual problems of industry and government."

And the report goes on to ask wha financial, accounting and contractin practices would result if industry an government considered their mutua business to be fundamentally development and systems management. ∎

(This is the second in a three-pa series. The first installment appeared Oc 28.)



VALUE of government contracts to seven largest captive nonprofit firms.

Improved Launch System for Polaris

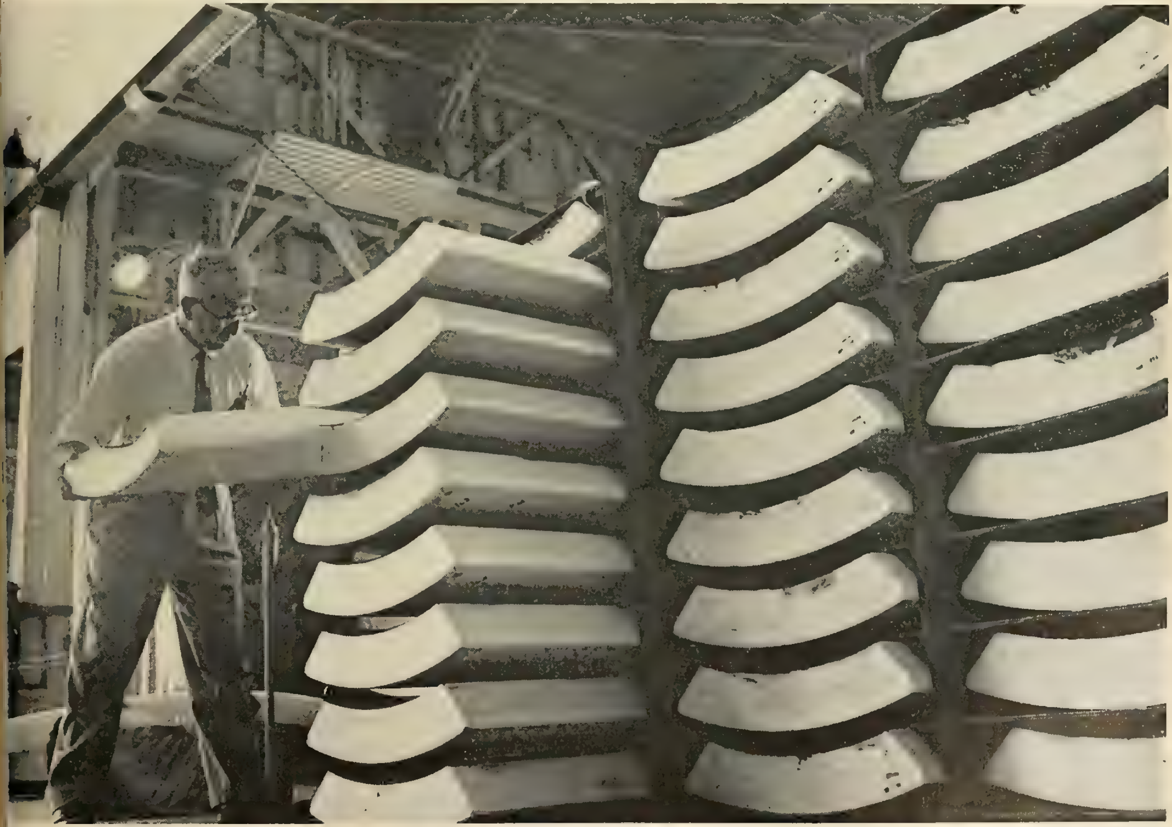
First details of Westinghouse advances—new launch tube suspension and steam launcher—which can handle bigger missiles

by Robert Lindsey

SUNNYVALE, CALIF.—Two advances in the *Polaris* Fleet Ballistic Missile (FBM) launching system developed here by the Westinghouse Electric Corp. open the way for possible future launching of larger, heavier versions of the Navy missile.

Besides offering growth potential, the second-generation, modular-designed Mark 21 launching system requires less shipboard maintenance than present launchers and offers substantial advantages in reliability, weight and space savings and simpler installation.

The improvements—a new launch tube suspension system and a steam launcher—were introduced into production models almost a year ago, but details are just becoming available now. All of the final 22 ships in the present 41 *Polaris* SSBN program will have the new systems. The first to use the steam-eject system is the USS Nathan Hale, while the first equipped with the new



ILLOWS of rigid polyurethane foam, shown in Westinghouse factory, are used in new-model Polaris launching system. Bonded o the outer shells of launch tubes with an adhesive, they provide shock support to the missile, together with a layer of flexible oam cushions. Foam is poured into a mold, hardened, trimmed and bonded to launch tube at spaced locations.

ejector and polyurethane foam support system is the USS James Madison. There are no plans at present to backfit the system into earlier submarines.

Westinghouse Corp.'s Sunnyvale Division is prime contractor for *Polaris* launching and handling equipment.

• **Foam suspension**—In present *Polaris* submarines the launch tube, a milled cylinder approximately 56 in. wide and 32 ft. long and composed of five welded segments, is hung from an outer mount tube by some 30 liquid "springs." These springs hold down the launch tube at its base also.

This suspension system must absorb the normal moments of force as a submarine heaves and rolls under normal seas or the violent motion caused by a depth charge attack. Suspended from the mount tube, the missile and its launch tube ride free of the motion, isolated from extreme directional forces. During a launch, the tube is tightened down.

Liquid springs have been a maintenance problem. Leaks at their seals have been a threat and required continual checking. Because the two tubes are relatively close, a matter of a few inches, access to the springs for repairs is difficult.

In the new system, the liquid springs are replaced by bands of polyurethane foam around the tube, which absorb shock as effectively as springs. Since they have no moving parts, there are virtually no maintenance problems. Liquid springs are used only to hold down the tube at its base.

The new technique utilizes the basic Westinghouse Mark 17 Model 2 launch tube, but it is modified slightly to accept a double mattress of foam.

Two types of foam are used: Cushions of rigid foam are applied around the tube as a cylindrical base for pillows of soft, flexible foam that actually do the shock mitigation.

The launch tubes and foam assemblies are encased in a thin steel jacket, with the annulus enclosed at each end by inter-tube seals. The new system weighs less than the liquid spring system.

A key advantage of the new system is that it is a modular package, tested at the factory and shipped as a unit. In effect, it applies the concept of modular electronics to a big ship fixture. The total package undergoes precise dimensional control at the factory, and it slips into the submarine as a unit. This eliminates some of the previous requirements for tight dimensional control at the shipyard. The launcher module even serves as part of its own shipping fixture.

Modularity provides interchangability with future systems that might be developed to launch missiles wider than the present 54-in. *Polaris* or which are heavier than the present model. The 2,500-nautical-mile-range *Polaris A3* weighs 31,500 pounds, compared to approximately 29,000 for the *A1* and 30,000 for the *A2*.

• **System details**—Although many details of the new system are classified, it appears that the flexible foam is comparable to the foam rubber in a household mattress, while the rigid foam is comparable to the styrofoam commonly used in Christmas decorations.

Both formulations are chemically of the polyurethane family. Westinghouse chemists developed the foams after considering hundreds of possible formulas in search of maximum reproducibility and predictability.

The hard foam is poured into a mold, hardened, trimmed and bonded to the launch tube at spaced locations down its length.

The flexible foam pillows are machined from large batts, planed to correct thicknesses on horizontal levelers and cut into pillows about 6 in. wide.

Assembled in groups of three, these pillows are encased with Teflon covers and mounted on the tube assembly, between an outer steel jacket and the spaces of hard foam on the launch tube; the tube can then slide up and down and has sideways freedom.

The outer jackets, which are approximately 8 ft. wide, are made from sheets of high tensile steel. Trimmed to size by a shearing machine, the sheets are formed into cylindrical segments on a rolling machine, welded and tested. Then a vertical expander, exerting up to 1,580 tons of hydraulic pressure, expands the thin wall jackets by up to an inch and assures that the tube is perfectly round.

The segment is trimmed to size, its edge prepared for welding and a circular seam welder joins the segments. After cleaning, phosphate coating and painting, openings in the jacket required for access to the missile (such as the guidance system port) are cut out by a plasma arc process.

• **Steam launcher**—In the second major improvement to the system, *Polaris'* bulky compressed air ejector is replaced by a simpler, yet more effective, system that blasts out the missile with live steam, generated by the exhaust of a small solid propellant rocket thrusting through a chamber of water. (see M/R Oct. 7, p. 17).

The new technique—which launches a missile in exactly the same time span as the compressed air system—eliminates the need for heavy flasks of air beside each tube.

This savings in weight and space, plus expected better reliability, led the Navy's Special Projects Office to consider steam launching at the outset of the program, but the idea was discarded because time was a crucial factor and compressed air technology was further advanced.

The heart of the new launcher is a programmed, solid propellant gas generator—a small rocket—developed by Allegany Ballistics Laboratory, and a cooling chamber mounted at an elbow flange at the base of each launch tube. A plastic membrane separates the fresh water in the chamber from the rocket nozzle.

The rocket is ignited by coded pulses that trigger an explosive bridge wire. When ignited, the rocket exhaust shoots through the membrane and into the chamber, turning the water instantly into steam.

Steam and cooled exhaust gas bursts through a pipe at the floor of the tube and pushes the missile up and out.

Westinghouse engineers say developing a gas generator with a controlled burning rate precise enough for the launcher was the hardest part of designing the new system.

Designed with a progressive grain, the rocket motor's burning rate is programmed so the volume of steam and exhaust blasting into the tube increases as the missile climbs up and the tube's unfilled volume increases; subtle increases in exhaust force must be generated so pressure remains constant.

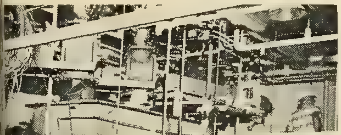
• **Propellant choice**—Westinghouse and Allegany engineers studied many propellant formulations in seeking optimum predictability and repeatability of the motor, as well as safety and storability. In the end a common (but undisclosed) propellant with a considerable history was chosen.

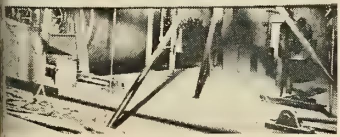
The rocket's case is heavy steel. To demonstrate its safety, the rocket was placed on a hot-oil-soaked wood bonfire where it remained without igniting for more than an hour. In another test the rocket was dropped 50 feet onto a steel plate and didn't detonate.

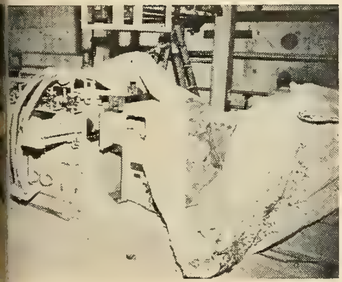
The new ejector pumps steam directly into the launch tube without the valve necessary in the present system. Cooling water is metered into the exhaust stream during the brief launch pulse—probably less than two seconds—so the hot gas doesn't harm the ascending missile.

It is estimated that a million watts of energy are used during a launch. ■

ƦIGHT: Aerojet's Dave Conklin sur- the massive reinforced concrete walls king off the continuous mix station. ,OW: One of the oxidizer grinding sta- ;. BOTTOM: The Baker-Perkins UK- continuous mixer installed in the par- y completed mixing building. Photos 'ack Levy.







Aerojet Gambles on Future of Solids at Florida Plant

Firm investing $21 million in Dade County plant that will transform Everglades site; to handle Phase I of AF Program

by John Judge

HOMESTEAD, FLA.—A $21-million Aerojet-General gamble on the future of large solid rockets is changing the face of 74,000 desolate acres deep in the Florida Everglades.

The South Dade plant will initially handle Phase 1 of the Air Force large solid rocket demonstration program—fabrication, loading and static firing of a half-length 260-in.-dia. rocket generating about 3-million lbs.' thrust.

The highly automated facility is designed for production of even larger units, and Aerojet is keeping the process as flexible as possible. The plant is planned on the experience gained in building the Sacramento, Calif., solid-rocket producing complex.

Aerojet owns 24,000 acres and has extensive leases, with purchase options on the rest. The south area—a portion of which is being developed as a solid rocket plant able to meet the demonstration program—has sufficient land to hold production facilities capable of producing up to 35-million lbs. of propellant a month. Test stand locations are easily able to handle up to 20-million lbs. of thrust.

The initial facility is but a tiny portion of the potential—although it is greater than that demanded by the current Air Force demonstration program.

- **"Nowheresville," Fla.**—The primary characteristic of a large rocket plant complex is isolation. The Aerojet territory nestles next to the forbidding Everglades, and the firm owns all the property from Route 1 west in the area.

Heavy reinforced concrete buildings mark the complex, along with artificial canals—created by the building of roads and excavations for the buildings. Access to the coast of Florida is provided by canals and a flood-drainage project approved by Congress scheduled for completion in 1965. These canals connect to the intercoastal waterway.

The Aerojet facility is being built with an eye toward the position of solids in 1975. The emergence of the large solid rocket has forced Aerojet out of the JATO propellant control problem into a batch-to-batch production control process—a far larger process involvement than the *Polaris* and *Minuteman* production problems met at the firm's Sacramento, Calif., works.

Aerojet will use both the continuous mix and batch method at the South Dade plant. The continuous-mix process is relatively inflexible since the time involved in changing propellant formulation is long. To this end, the propulsion firm is installing two batch-mixing stations.

The main idea is to maintain a high degree of flexibility in responding to advances in solid propellant processing while capitalizing their continuous mix experience.

Blending the various ingredients of a solid propulsion device and curing the composite is not a simple industrial method. Extreme care and pre-programming is needed, together with a highly sophisticated understanding of the procedure.

Producing a solid rocket is highly akin to bread making—but far more complex. The reliability of a solid grain is consciously worked into the final pouring.

Verification of this is embodied in the quality assurance procedures that operate in producing a solid rocket. In the Dade County complex, Aerojet has based the production flow on the quality-assurance reaction time.

Aerojet is looking to the massive solid booster and, together with Thiokol Chemical Corp., will present the government with a total industrial capacity for these vehicles within the next year.

- **Cast-fire pit**—Aerojet is building a cast-cure-test firing pit at the Dade County plant capable of handling the current large solid demonstration program and any follow-on to it. But the pit is also prepared for production modification.

The 150-ft. deep pit has already been blasted for possible future conversion into a tilt basin. This is a NASA concept in which massive solid motors may be loaded and cast in the vertical. Then the entire motor is lifted to the horizontal by water and made ready for immediate transport to the launching site by barge.

The ground around the present Aerojet pit has already been prepared for such a modification. There are no plans to proceed with this until the situation calls for it. In addition, the firm expects to learn a great deal from its initial pit-casting, curing and firing that will lead to modifications in the tilt design.

Aerojet is the only major propulsion firm to successfully apply continuous mixing to priority production schedules. The mixer itself accepts ingredients in minute increments and supplies a constant flow of propellant to the motor cases.

Because solids processing is a quantitative method, there are many constantly recurring problems with such a blender. Aerojet seems to have been able to surmount these in the *Polaris* program, but by their nature, each problem presents a slightly different face. The only answers possible come from experience and imagination.

High-energy solids, such as the slurry concepts now being pursued in various laboratories, lend themselves peculiarly to continuous mixing. But the degree of reliability and uniform performance characteristics of solid rockets come only from tested process methods. And the process is extremely dependent on the ingredients.

Thus the degree of success achieved in the final motor is a direct result of the care and knowledge fed into the producing method.

- **Prototype for future**—Aerojet spokesmen view the Dade County complex as the basis for the propulsion plant of the future. The solids operation occupies but a minuscule portion of the vast acreage available.

The upset squares arrangement is being utilized mostly as a fish and wildlife preserve. The current solids plant is situated close to the Everglades National Park and uses only the lower half of the Aerojet reservation.

The upper section, which comprises approximately half the property, may be the site of an extensive liquid propulsion facility. But only time and the shifting winds of the space business will dictate this.

The plant is being designed by solid propulsion experts and the entire facility will be based on an operational state of the art. There will be many minor innovations and shortcuts resulting from the experience at Sacramento in both construction and process flow.

In addition, raw materials delivery and acceptance will be slightly different, as will the entire quality control setup.

- **Present facilities**—The dozen or so buildings nearing completion at the site are geared to the 260-in. solid demonstration package won by Aerojet. All buildings are heavy, hurricane-proof structures packed with all the innovations in safety and automatic control devices found necessary or projected from experience gained in the *Minuteman* and *Polaris* production lines at Sacramento.

The oxidizer preparation facility is sized to feed the installation's mixing capability. The vertical blending process is highly flexible and versatile. The oxidizer blend—a combination of unground and particle-sized ground fractions—is the key to propellant burning rate and density.

Aerojet can grind either in-house or process vendor-ground oxidizer, depending on which approach is dictated by the particular propellant process.

The oxidizer-preparation building is highly automated and the pre-programmed blends are discharged into a portable hopper. A quality control sample is taken at this point. The oxidizer is then routed to either the batch or continuous mixing stations. If the former destination is involved, a pre-set amount of oxidizer is delivered, programmed for the particular batch. The continuous mixer meters its own oxidizer input.

The pre-mix or fuel preparation stream starts with the raw ingredients pumped through a loss-in-weight delivery system. The solid additives are added to the liquid components and blended in a 1,000-gal. tank equipped with a high-speed turbine agitator.

After mixing, the pre-mix increment is sampled for quality control and routed to a temperature-controlled, agitated storage tank. The pre-mix is then released to either the continuous mix or batch mixing stations.

If the pre-mix is bound for the batch mixers, a specified amount is dumped into the batch-mixer charging bowl on a controlled basis and delivered to the mixer. If the pre-mix is destined to the continuous mixer, the amount of delivery is regulatetd by the feeder system on the mixer or extruder.

The fuel-preparation facility is designed for the viscosity ranges of both composite propellant families—polybutadiene or polyurethane.

- **Mixing complexes**—Aerojet is installing three mixing stations at the south Dade plant—a continuous mixing unit and two 300-gal. vertical batch mixers.

The continuous unit is nominally rated at about 4,000 lbs. of propellant per hour. Each of the batch mixers has a nominal 4,500-lb./hr. output.

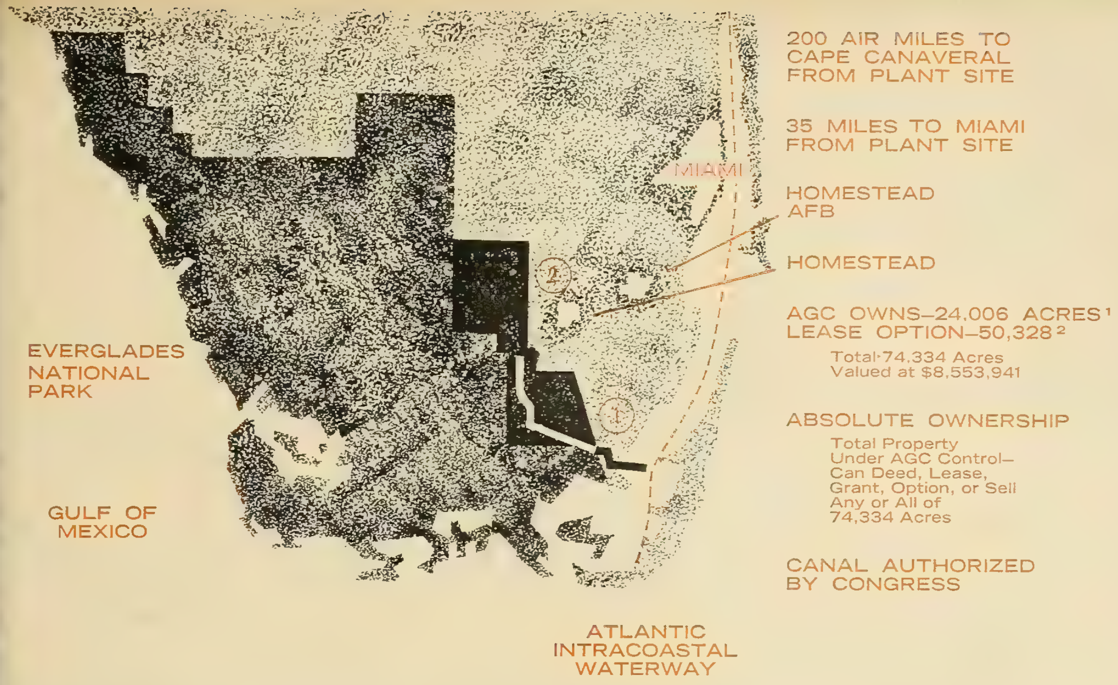
Three ingredient feed streams meet at the continuous mixer—oxidizer, premix and curing agent. The oxidizer is discharged into the mixer via a gravimetric belt feeder. Pre-mix is metered in on a loss-in-weight basis and the curing agent or final fuel is precisely fed into the mixer through a gear pump.

The propellant components are mixed with a rotating, reciprocal, interrupted flight helical screw. The combined reciprocal and rotary motion achieves an extremely well-blended mixture.

The propellant is fed into a vacuum de-aerator immediately after the mixing cycle, eliminating any trapped gases. A series of on-stream instrumentation then checks the flowing propellant mass.

An X-ray spectrophotometer checks oxidizer proportioning, an infrared analyzer measures fuel component ratios and a gamma-ray instrument keeps tabs on the propellant density.

- **Deflagration precautions**—Damage controls have been built into the


200 AIR MILES TO CAPE CANAVERAL FROM PLANT SITE
35 MILES TO MIAMI FROM PLANT SITE
MIAMI
HOMESTEAD AFB
HOMESTEAD
AGC OWNS–24,006 ACRES 1
LEASE OPTION–50,328 2
Total·74,334 Acres
Valued at $8,553,941
ABSOLUTE OWNERSHIP
Total Property
Under AGC Control–
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ontinuous mixer system, but Aerojet gineers do not expect high order detations. Fire is a much more likely ossibility and isolation is the key to ndling such an emergency.

The mixer discharges propellant into e of two stainless steel hoppers for elivery to the casting site. The dual scharge system assures uninterrupted elivery throughout the entire mixing cle.

Batch mixer inputs are carefully eighed and checked at the respective gredient preparation buildings and elivered to the mixer. Weights are gain checked and the vertical mixing cle begins. Curing agent is added dictly at the mixer.

All propellant operations at the ade Plant are automatic and most of e ingredient preparation processes are so automated. Quality assurance and producibility are the main reasons for tomation—not economics.

There are innumerable in-process uality checks throughout the entire oduct flow. After mixing, the propelnt is sidelined for a short time while nal quality checks are being run.

The whole process flow is somewhat iented to quality control demands. e timing is so arranged that the retion time of the quality control lab less than that required to deliver prollant to the casting site.

Small qualifying motors of 5 and 100 lbs. will be poured during the main mix cycle. The smaller motor is for burning rate checks and the larger for specific impulse measurements. These are after-the-fact tests designed to recheck the entire system. The results from these back-up tests will arrive long after the particular propellant batch is cast in the demonstration motor.

- **Inert parts prep**—The massive 260-in. diameter maraging steel, half-length motor case will be thouroughly inspected by Aerojet at the vendor's plant. Only a check of transportation damage will be performed at the Dade plant when the case is delivered.

The case will be shunted directly to the general process building where it will be cleaned, insulated and lined with a chemical having the same composition as the inert components of the propellant.

Once the liner is in, the chamber will be sealed and delivered to the casting pit. The motor case will rest in the pit so that the nozzle is above ground level. A casting head will be installed after the propellant core mandrel is inserted.

The casting operation for the half-length 260-in. demonstration rocket will involve two to three weeks of continuous work. The cure period will run between 10 and 14 days. After the cure cycle, the core will be stripped and the motor cooled by air purge.

Aerojet will use a collapsible-bayonet casting technique. The propellant must be cast without trapping air. A self-collapsing hose was developed for the process by Aerojet and B. F. Goodrich.

When the first propellant delivery pot is released to the casting phase, this hose will be connected to the casting complex. A vacuum will be pulled on the plugged hose, collapsing it. Propellant will then be forced into the collapsed bayonet.

The propellant will force the end-plug out of the hose, and the plug, held by a wire, will return to the surface. The support stand for the casting pots is hydraulically jacked through a 10-ft. vertical movement.

The bayonet end is kept at the propellant surface in the case by raising the platform. When the 10-ft. limit is reached, a pig run down the tube cleans out the propellant. A 10-ft. section is cut from the bayonet and the whole system is re-collapsed. The casting operation is started again.

A system of valves on the loading hopper handles both the bayonet shortening and replacement of propellant delivery pots. There will be three bayonet systems in the 260-in. loading phase. ■

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Vector Technique Speeds C&C Computer Capability

Small computer for next-generation command and control systems up to 30 times faster; smaller, cheaper and more reliable than present systems; Martin-Orlando details

NEXT-GENERATION military command and control systems may be significantly improved with a new approach to the computer subsystem developed by Martin-Orlando.

Called the Vector computer, this general-purpose parallel-digital computer combines the strong points of both digital and analog computation. Developers claim a big advantage in speed and reliability as well as savings in cost and size.

The unique feature of the vector is the addition of two other commands—"rotate" and "vector"—to the normal digital capability of four arithmetic operations. These added commands provide direct solutions to an entire set of trigonometric equations, heretofore available only with analog methods. Thus, the direct high-speed capability of analog computation is combined with the standard virtues of digital equipment.

The vector has demonstrated operational speeds 4 to 30 times faster than conventional general-purpose digital computers in solving the common problems associated with command and control. These are the typical recurring trigonometric solutions normally encountered in the conversion of slant data to ground-plane coordinates, and the reverse.

The more trigonometry involved, the faster and more efficient the vector, Martin engineers claim.

General-purpose digital computers, such as those used in existing command and control systems, can solve trigonometric equations, but the technique requires a multitude of time-consuming operations. And to meet real-time requirements, a brute-force method is often used: adding circuits and memory capacity and/or increasing circuit speeds and clock rates. This, logically, adds to equipment size, weight and cost, greatly reduces reliability and increases maintenance problems.

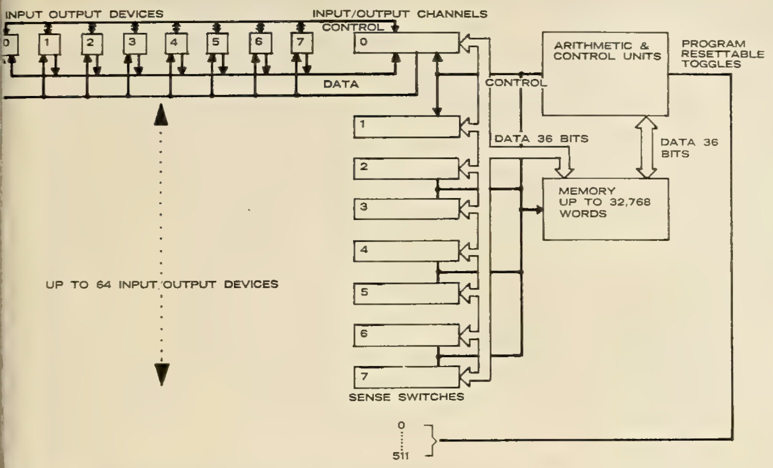
Dr. David Clutterham, head of Martin-Orlando's information sciences laboratory, disclosed that the company has been working on the vector for a number of years. A working model has been under evaluation for the past several months. A smaller serial version already has been incorporated successfully into a digital fire-unit integrating facility as a possible replacement for analog units in existing C&C systems.

According to Clutterham, the vector technique itself is not new, but this is

GE Awards for Tubes

GENERAL ELECTRIC Co. has received new Defense Dept. contracts totalling $1.25 million for development work on a new generation of very-high-power electron tubes.

The work, involving a multiple-beam klystron and travelling-wave multiple-beam klystrons, is funded by DOD's Advanced Research Projects Agency as part of Project Defender. Managers at GE's Schenectady, N.Y., tube operation said the contracts provide for several new types of tubes, including an S-band tube with peak power output of 10 megawatts and a 15% bandwidth.



BLOCK DIAGRAM of Martin's new Vector computer.

the first time it has actually been incorporated into working off-the-shelf parallel computer hardware.

Martin is not a commercial computers manufacturer. Its computer work s all centered around C&C applications such as the Army's BIRDIE and Missile Master, both Martin-built area-defense systems.

• **Why developed**—The vector computer was developed by Martin-Orlando as part of a continuing in-house program aimed at improvement of existing C&C systems to meet new requirements. The increasing speed of vehicles, ncreasing complexity of C&C situaions, and stringent limitations in size, weight and power consumption in space and military applications call for computers that can provide real-time soluions with greater speed, accuracy and eliability and with less equipment and ess power.

Vector's speed advantage comes from its rotate-and-vector capability—not from increased power, clock rate or memory capacity. Rather, developers believe, the vector can do the same job with less equipment and power and lower clock rate than a conventional omputer.

The command-rotate function can be roughly compared to the "non-restoring division" technique commonly used in computation. Here, the correct solution is found by an add-and-subtract technique that narrows down the process until it zeroes in on the answer.

In the vector, rotation through an angle is done by a similar process—adding or subtracting each member of a series of carefully selected, predetermined angles. The rotate command can solve a pair of equations by a simple series of digital computer steps in a single command whose complexity is equivalent to division in a conventional digital computer.

As an example, a typical problem might require computer solution of height and ground range from radar-supplied slant range and elevation angle. Resolving these to a regular set of x-y equations, the vector, with a single rotate command, performs the complete operation in the same amount of time required for one division on conventional equipment.

By contrast, the conventional computer must use some method such as polynomial approximation, requiring 14 multiplications and 11 additions to derive sine and cosine, then compute four more multiplications, one addition and one subtraction—a total of 31 distinct operations, each requiring a separate command.

• **Broad applications**—The relatively small size of the vector derives from the fact that it can do the same job with such a slow clock rate—100 kc, for example—that miniaturized components, which are generally not reliable at the higher rates, could be used. Martin says that one study of a possible missile guidance application showed that a total weight and size reduction of 90% could be achieved.

Increased reliability comes directly from the use of less equipment and fewer components. The vector design uses some 50% fewer different circuit types than conventional models, reducing failure rates by up to a factor of four to one, according to Martin estimates. In addition to increasing relia-

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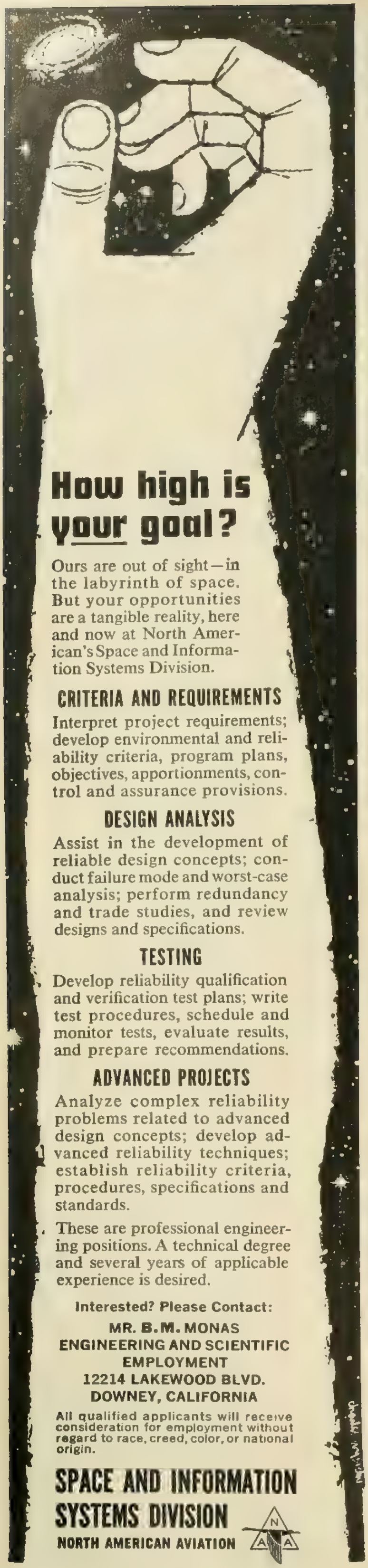

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bility, the logistic support problem is also greatly reduced.

The vector technique may also find application in a number of other areas: ATC and automatic landing systems and space vehicle navigation, for example, in addition to the primary role foreseen for defense control systems.

In all these possible applications, vector's advantages are said to lie in its speed, compactness and reliability.

- **Versatility detailed**—In command and control of defense against ICBM's, for instance, where tracking incoming warheads, converting and coordinating data and guiding interceptors all involve a high percentage of trigonometry, the vector computer can provide highly accurate real-time solutions with less equipment, greater reliability and greater ease in logistics.

In aircraft control, both military and commercial, the vector would be able to quickly convert all data inputs into a common coordinate system, compare actual positions with flight-planned positions, foresee any problems, alert the controller and relay necessary information to all units.

In automatic landing systems, the computer's efficiency in solving trigonometric problems permits a sizable reduction in the amount of digital equipment necessary, thus increasing the feasibility of substituting digital for analog equipment in many situations.

In space vehicles, the vector could reduce both weight and power consumption of navigation equipment, since it uses fewer components operating at slower speeds to solve the trigonometric problems involved. ■

WELDED-MODULE circuitry and miniaturized components give compact Martin Orlando Vector computer the capacity of much larger systems for many command and control applications. Addition of "rotate" and "vector" commands to normal digital computer capability provides trigonometric solutions up to 30 times faster than with conventional equipment, developers claim.

Mergers and Acquisitions

Teledyne, Inc., Calif., has acquired the Optical Products Div. of Consolidated Systems Corp. to supplement existing facilities with a greater infrared and ultraviolet capability. Teledyne, which develops and manufactures electronic systems and equipment in engineering and manufacturing plants throughout the U.S., recently expanded into the fluid control field with the acquisition of Sprague Engineering, Calif. . . . *Stockholders of Allied Research Associates, Inc., Concord, Mass., have voted in favor of sale of the firm's assets to United ElectroDynamics, Inc., Pasadena, Calif. Directors of both companies previously approved the transaction.* . . . General Applied Science Laboratories, Inc., Westbury, N.Y., has acquired Janus Products, Inc., developers and producers of ultrasonic devices. Janus will be operated as a wholly-owned subsidiary of GASL at its same location in Syosset, N.Y. GASL is a producer of electronic components, instruments and systems.

New Firms and Divisions

David Industries, Santa Ana, Calif., an electronics and instrumentation company has formed a new subsidiary, Electro-Metrology Corp. The firm, also to be located in Santa Ana, will specialize in the development and manufacture of time and frequency systems and instrumentation. . . . *Electra Manufacturing Co., Independence, Kan., electronic components firm, has formed a Distributor Products Div. in a move to strengthen its distributor network and to improve coordination with its distributors and sales force.* . . . The Grigsby Co., Inc., Arlington Heights, Ill., manufacturer of low current switches, reed relays and electrical devices, has been renamed Standard Grigsby, Inc. The change was made "to more fully describe the electronic components firm since its acquisition earlier this year by Standard Kollsman Industries, Inc., Melrose Park, Ill." . . .

International

National Research Corp., Cambridge, Mass., a subsidiary of Norton Co., has licensed Linde Eismaschinen of Germany to use its superinsulation material, NRC-2. LE is a European manufacturer of compressed and liquid gases. The product, NRC-2, is used to insulate tanks for storage and transport of cryogenic liquids and thermal insulation of spacecraft components.

Industry Facilities

Douglas Aircraft Corp. has opened a new $25-million Space Systems Center at Huntington Beach, Calif. The center presently consists of nine buildings on a 245-acre site. Plans call for eventual expansion to 17 buildings, valued at some $75 million. The center will include a space simulation chamber, a structures laboratory, a manufacturing and assembly building, an engineering complex, a tooling complex and a production test laboratory. . . . *Dunlap and Associates, Inc., Darien, Conn., research and analysis firm, will open a new headquarters building Dec. 5. The building will be staffed by more than 100 personnel. It will house the firm's executive and research staff and accounting offices, a research laboratory, library and an editorial department.* . . . United Control Corp. is planning to transfer its wholly-owned subsidiary, Palomar Scientific Corp., Palo Alto, Calif., to the electronics facilities of the parent company at Redmond, Wash. The move is aimed at reducing costs and increasing competitive advantages from the sharing of common facilities, equipment and staff. . . . *Chrysler Corp., Detroit, Mich., has opened a new Florida Operations facility less than a mile from the Cape Canaveral Missile Test Annex. The facility consolidates all Chrysler missile and space operations in Florida into one plant engaged in design, development, manufacture, installation and maintenance of missile and space vehicle ground support equipment and instrumentation systems for various Government agencies and private contractors in the area.* . . . Liquidonics, Inc., Westbury, N.Y., hydraulics component manufacturer, is moving its plant and executive offices to 200 Shames Drive in Westbury. The new plant is more than three times the size of the present Liquidonics building. . . . *Bjorksten Research Laboratories has broken ground for an office building at its headquarters at Fitchburg Research Park near Madison, Wis. The new building will have approximately 5,000 sq. ft. of floor space. Space in the main laboratory building being made available by the construction is to be devoted to expansion in high temperature research facilities.*

Company Representatives

Optics Technology, Inc., Belmont, Calif., has named Northeast Associates, Marblehead, Mass., sales representative for New England and northern Connecticut. OTI conducts advanced optics research and manufactures special devices and instruments in the fields of fiber optics, lasers, thin films and photo-electronics. . . . *Gertsch Products, Inc., Los Angeles, has appointed Dynamics Associates, Burlingame, Calif., sales representative in northern California and western Nevada to represent the Gertsch line of precision instruments.* . . . De Mornay-Bonardi Div. of Datapulse, Inc., Pasadena, Calif., has named Carter Electronics, Inc., Chicago, sales and engineering representatives in Minnesota, Wisconsin, Indiana, Iowa, western Kentucky and northern Illinois. . . . *Chemical and Aerospace Products, Inc., Gardena, Calif., has appointed two sales representatives for its line of preformed circuitry and laminates. Tom Yeakle, Pasadena, Calif., will cover the southern California area. A&E Sales & Supply Co., Arvada, Colo., will handle the state of Colorado.* . . . Industrial Instruments, Inc., Cedar Grove, N.J., has appointed Welco, Inc., to represent its line of electrical/electronic equipment in California and Nevada.

TV Camera Tube 'Sees in Dark'

THROUGH USE of the principle of secondary electron conduction, a highly sensitive television camera tube has been developed having an extremely broad dynamic range.

Called the SEC-vidicon, the tube automatically adjusts its output to compensate for ambient light level, producing a visible image of objects too dark to register on photographic film, yet showing no "blackout" or flare from sudden bright light sources or reflectors. Also, the camera tube solves the problem of smear or picture lag that has limited vidicon tubes previously.

Since it virtually sees in the dark, Westinghouse Electric Corp. scientists who developed the unusual vidicon tube see great promise for its future use in space exploration particularly with respect to early viewing of the dark side of the Moon.

The instrument, in addition to providing fine sensitivity and high resolution, offers other desirable characteristics for surveillance or reconnaissance applications, according to developers.

It will tolerate without overloading or delicate adjustment a wide range of light intensities, permit the slow buildup of integration and storage of electronic images over long time periods without degrading output quality, respond rapidly, and operate uniformly over a wide temperature range. The tube is electrically stable and provides a low noise figure.

R&D work on the SEC-vedicon was funded in part by the U.S. Army's Electronics Research and Development Laboratory, Fort Monmouth, N.J., and by the Avionics Laboratory of the USAF Electronic Technology Div. at Wright-Patterson AFB, Ohio.

- **SEC-vidicon operation**—The new Westinghouse tube consists of three primary components: a highly sensitive photocathode; a thin-film target, and an electron gun.

The photocathode releases electrons in proportion to the amount or intensity of illumination. The thin, porous film serves as a medium in which the electron image is amplified and stored. Accelerated photoelectrons in the film generate a vast number of secondary electrons which are rapidly swept out of the film by means of an applied electric field, leaving behind an amplified charge image.

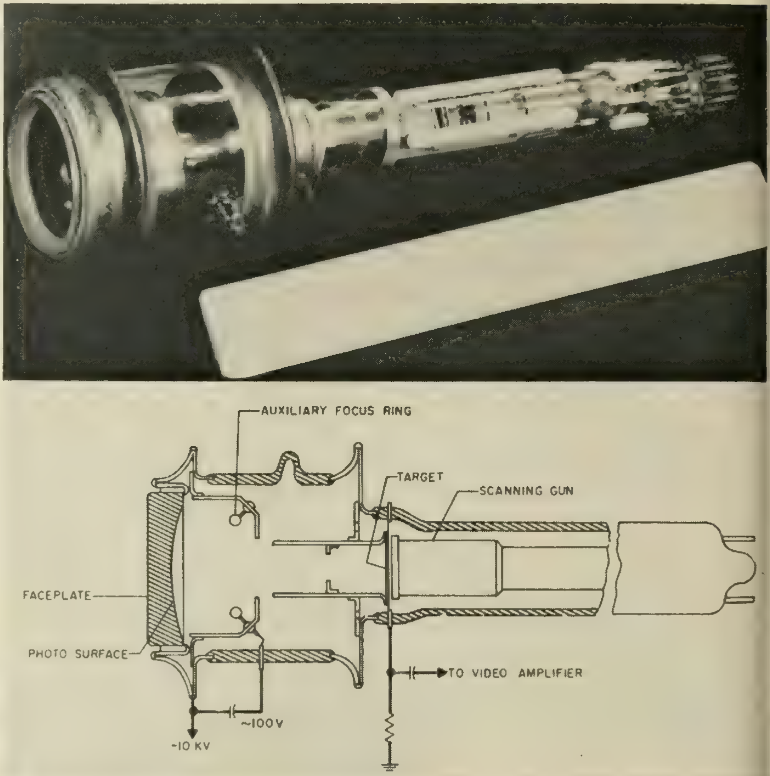
(The resulting net charge gain is of the order of 200 to 300, said one scientist. Because these secondaries are produced within an insulating material, no current actually flows in the absence of the excitation signal. Thus, the film serves as an almost ideal memory unit between scans of the reading beam.)

The electron gun scans the target and releases an electrical charge pattern. The latter is a series of amplified pulses comparable to the original light image.

- **Film storage**—The thin film providing electron image storage is made up of an aluminum oxide supporting layer 500 to 1,000 Angstroms thick. This is coated with a vapor deposited conductive layer of aluminum 500 Angstroms thick. A low-density deposit of potassium chloride covers the aluminum layer to a depth of about 25 microns.

During tube operation, the thin-film is polarized by application of a positive voltage to the aluminum layer. The KCl layer is stabilized at ground (gun cathode) potential.

Electrons, at roughly 10,000 electron volts, impinge on the target from the aluminum oxide layer and actually penetrate this supporting structure and the aluminum layer. Much of their (electrons') initial energy is dissipated within the KCl layer, creating conduction electrons and free secondary electrons. ■



SEC-VIDICON TUBE developed by Westinghouse produces TV quality images of objects in almost total darkness. This advanced version uses electrostatic focus and will be used in Project Celescope, one of NASA's planned Orbiting Astronomical Observatory satellites.

Circle No. 225 on Subscriber Service Card

S-Band Diode Amplifier

International Microwave Corp. is marketing a broad-band, high-gain, low noise tunnel diode amplifier at S-band.

The device utilizes two single-stage tunnel diode amplifiers in cascade and is stabilized for a minimum of 24 hrs. at 200 times. The amplifier is centered at 2,850 mc. It has an RF pass band of 500 mc, and an overall noise figure of 4.7 db. Minimum gain is 25 db ± 1 db over the temperature range of —30° to 60°C.

Power requirements are 10 to 15v dc with less than 10 milliamps dc current. DC voltage surges of 1,000% can be tolerated without degradation to the diode.

Circle No. 226 on Subscriber Service Card

20-Channel Multiplexer

Data Systems Div. or Harman-Kardon, Inc., has available a solid-state multiplexer capable of handling 20 or more channels of analog data.

Operation of the Model 902 is synchronous or asynchronous to 10 kc. Normal switching speed is 20 μsec. Skip speed is 4 μsec/channel. Maximum noise is 100 μv. The unit meets MIL-E-5272C requirements.

Circle No. 227 on Subscriber Service Card

Transistorized Power Supply

Electronic Research Associates, Inc., has available the Model TR040 transistorized power supply featuring adjustable current limiter, remote programming, short-circuit-proof design, series or parallel operation and remote sensing.

Specifications include an input of 105 to 125v ac, 50 to 1,000 cps, and regulated output of 0 to 40v dc at 0 to 500 ma. Line regulation exceeds ±0.015% or 5 millivolts. Load regulation is better than 0.03% or 5 millivolts for 0 to 100% load change. Ripple is less than 1 mv RMS. The current limiter covers the range from 100 to 700 ma.

Circle No. 227 on Subscriber Service Card

Resistance Analyzer

Cornell-Dubilier Electronics Div. of Federal Pacific Electric Co. has developed the BF-71A capacitance-resistance analyzer. Measurements are made using a Wien Bridge, which operates from a 60-cycle line frequency and uses an electron "eye" tube indicator.

The unit provides a 0 to 500v variable dc supply for measuring leakage current at rated capacitor voltage. It measures capacitor values from 10 mmfd to 2,000 mfd; resistor values from 2.5 ohms to 25 megohms; capacitor leakage current from one microamp to 100 milliamps; and power factor measurements from 0 to 50% at 60 cycles. Sensitivity is 10,000 ohms/volt.

Circle No. 228 on Subscriber Service Card

Data Transmitter

Kellogg Communications Systems Div. of International Telephone and Telegraph Corp. is marketing the Model KD-5040 solid-state data transmitter, employing printed circuits.

Features include a parallel-to-serial converter, a vertical parity detector and a horizontal parity generator. The unit meets specifications for MIL-E-4158B, MIL-T-4807A, MIL-R-26474 and MIL-STD-188A.

Circle No. 229 on Subscriber Service Card

Matched Hybrid

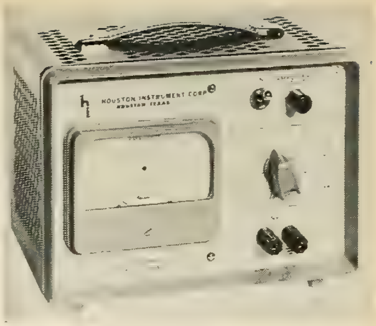
Adams-Russell Co., Inc., has available the Model HV matched hybrid, a device that covers frequencies from 20 to 200 mc.

Amplitude balance between outputs is within 0.2 db; phase balance is within 1.0°. The unit has an isolation that exceeds 30 db and an insertion loss of less than 0.5 db. VSWR is less than 1.2.

Circle No. 230 on Subscriber Service Card

AC Millivoltmeter

Houston Instrument Corp. has available the Model VM 77B millivoltmeter, featuring 12 ranges between 0.001 and 300v ac, full scale. Frequency range is 10 cps to 4.5 mc.



The unit has an input impedance of 10 megohms, shunted by 20 pf. Calibration accuracy from 50 cps to 100 kc is ±3% FSD, and ± (3% + 3% FSD) from 15 cps to 2 mc. Between 2 and 4.5 mc, accuracy is ±2 db.

When used as an amplifier, the device has a maximum gain of 60 db, adjustable in 10 db steps, and a maximum output of 1v RMS. Accuracy is preserved for power source variations of 115v ac ±10%.

Circle No. 231 on Subscriber Service Card

Laser Energy Measurer

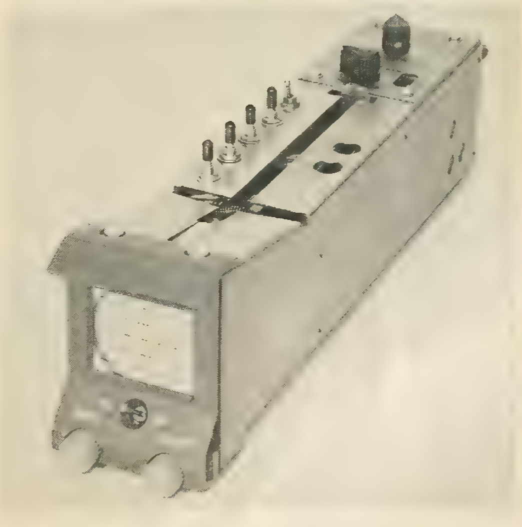
Laser Systems Center of Lear Siegler, Inc., has developed a device that measures laser energy during actual operation.

The Model MI-2 laser energy monitor utilizes a beam sampling technique, sampling only a small percentage

New Product of the Week: Monitor Oscilloscope

The Model 12-677 monitor oscilloscope, permitting operation with 1.5-mc wideband recorders, has been developed by Consolidated Electrodynamics Corp. of Bell & Howell Co.

The device provides visual display of signals in the dc to 1,500,000 cps range. It can be used with magnetic tape recorders or any multichannel instrumentation system. The unit accommodates up to seven of the scopes.



Circle No. 232 on Subscriber Service Card

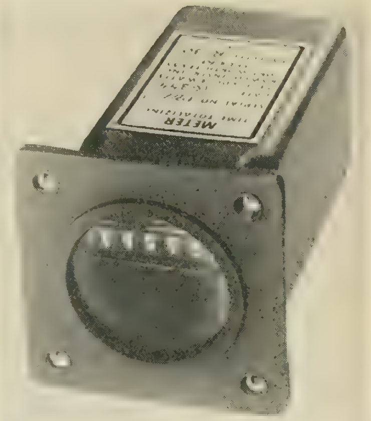
of the laser output, thus enabling the beam to continue work during measurement. A direct meter readout of energy in joules provides a full scale accuracy of ±5%.

The unit thas a holding circuit that permits readings within 30 seconds after the firing. A manual reset button returns the needle to zero. Natural decay time of the circuit is approximately 1,000 seconds. Attenuators permit full scale readings of from 0.03 joules to several thousand joules. Response time is 4 nanosec. The device accepts beam outputs up to 1¼ in. in diameter and has an operating range of 0.35 to 1.3 microns. No conversion factors are required when the unit is operated at 6,943 Å.

Circle No. 233 on Subscriber Service Card

Elapsed Time Indicator

The Model 610 Universal AC/DC Elapsed Time Indicator is being marketed by RAWCO Instruments, Inc. The unit records up to 10,000 hours with a five-place digital readout in hours and tenths of hours.



The device operates from a 28-v dc system or a 28-v ac system, 50 to 400 cps. Hold accuracy is ±10% for voltage variations of a ±4v over a temperature range of 40° to 90°F. Other voltages may be accommodated by use of an external transformer or voltage divider.

Circle No. 234 on Subscriber Service Card

DC-DC Relay

Hi-G, Inc., has available the Model 2200 solid-state relay for dc-dc functions. The device has a SPST configuration with 6 to 12v dc at 100 ma maximum.

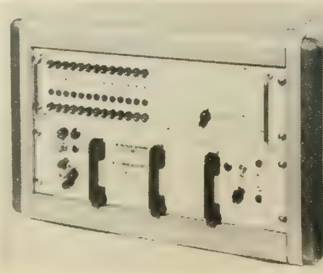
The model is capable of switching 50v dc at 25 ma to 1 ampere, depending on ambient temperature. Forward voltage drop is 2v at 25°C. Leakage current is 2 μ amps at 25°C with a load of 50v dc.

The unit has a maximum switching rate of 100 cps under full load conditions.

Circle No. 238 on Subscriber Service Card

Encoder Test Set

J. W. Fecker Div. of American Optical Co. is marketing a high-precision encoder test set to meet the need arising from increased use of analog to digital shaft position encoders. The unit comprises a self-checking system that operates at rates up to 50,000 bits per second.



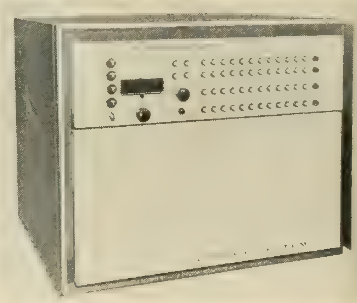
The solid-state device performs operational error detection for 13 bit "V" scan and 13 bit "Gray" scan encoders. Performed over 360 degrees of encoder rotation, the test can be completed in the time interval determined by the maximum encoder rotation rate. The set is adaptable to other types of encoders by replacement of the interrogation and conversion drawer.

Circle No. 235 on Subscriber Service Card

Memory System

The Series 52.10 memory system, featuring sealed modules with readily accessible test points for easy maintenance, is being marketed by the Ferroxcube Corp. of America.

The solid-state unit is available with capacity ranges from 32 to 16,384 characters in various bit lengths. It offers cycle times of full 10 μsec and half 6 μsec, in sequential, sequential interlace and random access modes. Input and output levels are 0 and −6v standard, and other pulse levels are available. Optional level shifts for control can be provided.



Other features include built-in checking circuitry, a regulated power supply and address and data information indicators.

Circle No. 236 on Subscriber Service Card

Sealed Capacitor

The Gudeman Co. of California, Inc., is marketing the 51B series of hermetically sealed capacitors, designed for higher capacitance per unit volume. For example, the 100-v model is said to offer a capacitance of 0.33 mfd. as compared to 0.10 mfd in a previous model of the same size.

The units have a dissipation factor of less than 1.0% and operate in environmental temperatures up to 125°C. Suitable for both ac and dc applications, the units are available in a range of capacitances from 0.001 to 10.0 mfd in the 100-v dc ratings to 2.5 mfd in the 600-v dc types.

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AWARDS

AIR FORCE

$10,600,000—**Aerospace Corp.**, El Segundo, Calif., for general systems engineering and technical direction for missile and space programs.

$5,700,000—**General Precision, Inc.**, Little Falls, N.J., for flight tests related to feasibility of the stellar inertial guidance system.

$2,800,000—**Philco Corp.**, Willow Grove, Pa., for production of a computer for a combat operations center.

$2,000,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for services and related equipment for an unidentified launch vehicle program.

$1,900,000—**Aerojet-General Corp.**, Sacramento, Calif., for work on improved engines for the *Titan I* ICBM.

$1,400,000—**Avco Corp.**, Wilmington, Mass., for continued work on a classified program.

$1,300,000—**Analytical Services, Inc.**, Alexandria, Va., for studies of tactical and strategic air-defense methods and logistics operations.

$755,000—**Houston Fearless Corp.**, Los Angeles, for design and development of a mobile electro-optical data reduction unit.

$600,000—**Electronics Associates, Inc.**, Long Branch, N.J., for a HYDAC 2400 model computing system for installation at Flight Test Center, Edwards AFB, Calif.

$271,000—**Sylvania Electric Products, Inc., Electronic Systems Div.**, Waltham, Mass., for technical instruction of AF personnel in the operation and maintenance of classified electronic equipment, with work to be done at Ellsworth AFB, S.D.; RADC, Rome, N.Y.; Keesler AFB, Miss., and overseas installations in Britain and Italy.

$231,810—**A. D. Little, Inc.**, Cambridge, Mass., for research to determine physical properties of probable lunar materials in a simulated lunar environment.

$200,000—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for continued study and performance evaluation of various missile systems for SSD, Los Angeles.

$29,721—**Laboratory for Electronics, Tracerlab Div.**, Waltham, Mass., for studies of solid-state electronic materials.

Sylvania Electric Products, Inc., Waltham, Mass., for construction of a compact model of its company-developed wideband laser modulator (undisclosed amount).

NAVY

$30,200,000—**Hughes Aircraft Co.**, Culver City, Calif., for continued development of the *Phoenix* air-to-air missile which will equip the F-111 aircraft.

$12,000,000—**Maxson Electronics Corp.**, Great River, N.Y., for production of components for the *Bullpup* missile.

$4,759,450—**Technical Materiel Corp.**, Mamaroneck, N.Y., for communications equipment.

$2,700,000—**Raytheon Co.**, Waltham, Mass., for a classified electronics project.

$1,000,000—**Talley Industries, Inc.**, Mesa, Ariz., for solid-propellant gas generators for the *Tartar* missile system.

$41,000—**Astrophysics Research Corp.**, Los Angeles, for studies of ionospheric disturbances arising from missile launches.

NASA

$327,836—**GPS Instrument Co.**, Newton, Mass., for an analog computer.

$145,700—**Systems Engineering Laboratory**, Ft. Lauderdale, Fla., for a high-speed digital recording system.

$91,166—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for Project Fire flow-field prediction and analysis.

$48,845—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for Project Fire flow-field prediction and analysis.

$40,150—**North American Aviation, Inc., Space and Information Systems Div.**, Downey, Calif., for Project RAM flow field prediction and analysis, phase II.

General Electric Co., Spacecraft Dept., Valley Forge, Pa., for establishment of guidlines for the design and manufacture of sterilized space vehicles. (undisclosed amount).

AEC

Central Scientific Co., Chicago, for one-year's supply of mechanical vacuum pumps and related equipment for the Oak Ridge National Laboratory, Oak Ridge, Tenn. (undisclosed amount).

GENERAL SVCS. ADMIN.

$300,000—**Douglas Aircraft Co., Inc.**, Charlotte, N.C., for a research program for a high-velocity free rocket.

INDUSTRY

$400,000—**Consolidated Systems Corp.**, Monrovia, Calif., from **General Electric's Light Military Electronics Dept.**, for design and development of a radarscope recording camera.

GENERAL PROCUREMENTS

U.S. Navy Department
Bureau of Ships
Washington, D.C.
20360

Research and development to design, build and test a range and bearing test set and furnish repair parts and associated technical data and reports for the AN/SQS-26 sonar system. RFP 688E-2901.23 (S). General Electric has the experience and detailed knowledge of the required background to perform the research and development work involved in this procurement by virtue of its work on an existing bureau contract. Request for proposal has been issued to General Electric Co., HMED, Electronics Park, Syracuse, N.Y. Prior security clearance will be required of interested firms.

National Aeronautics and Space Administration
Headquarters, Contracts
Washington 25, D.C.

NASA is negotiating a contract with Kaman Aircraft Corp., Bloomfield, Conn., for a study of a synchronous gyroscope vibration absorber. No RFP available, for information only.

Directorate of Research and Development Procurement
Systems Engineering Group (RTD)
Wright-Patterson Air Force Base, Ohio

Research leading to the development of a quantitative motion monitor for the investigation of the dynamic motions of the human body organs and segments during acceleration. The item to be developed shall include necessary data-handling equipment for visualization and tracking of body parts during acceleration. The research program shall include four phases as follows: (1) Design (2) Fabrication, checkout and delivery, (3) Acceptance testing by the contractor at Wright-Patterson AFB, and (4) Demonstration and lectures to AF personnel. Request for this RFP must be made in writing. Address your request to Research and Technology Div., Attn: SEKMB. RFP NR. 342-61127-MB.

Directorate of Procurement
Deputy Chief of Staff
Material Air Proving Ground Center
Eglin AFB, Florida

Continuation of the effort initiated under AF contract 08(635)-902 with ITT Research Institute Chicago, Ill., is contemplated. This notice of a space encounter modeling study is to be completed

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under REQ ASQW 64-441 is for information only, no RFP available.

Systems Engineering Group
Research and Technology Div.
Wright-Patterson AFB, Ohio

Contract for research and development for investigation of high voltage thermionic converters is to be negotiated with General Motors Corp., Allison Div., Indianapolis 6, Ind. PR 6875. For information only, no RFP available.

National Aeronautics and Space Administration
Headquarters—Contracts
Washington 25, D.C.
Attn: N. A. Miller

NASA is negotiating a contract with United Aircraft Corp., Research Labs, East Hartford 8, Conn., for an investigation of gaseous nuclear rocket technology. For information only, no RFP available.

USAMICOM
Redstone Arsenal, Ala.

Attn: Directorate of Procurement and Production
(AMSMI-ISPM)

Capital equipment in support of research and development effort for the *Redeye* missile system. Deliveries to Culver City, Calif. Procurement of this equipment will be from Hughes Aircraft Co., Culver City, Calif. All inquiries relative to subcontracting should be referred to the above contractor.

Office of Naval Research
Washington 25, D.C.

Negotiations are to be conducted with Ball Brothers Research Corp., Boulder, Colo., for further research involving the development, design, modification, fabrication and testing and pointing controls and telemetry systems under Contract No. 2938(00)(X). This is for information only, no RFP available.

Negotiations are to be conducted with the Electronic Research Div. of Clevite Corp., Cleveland, Ohio, for further research on transducer materials under Contract No. 3958(00). This is for information only, no RFP available.

Bureau of Naval Weapons
Washington 25, D.C.

Repair and overhaul of *Polaris* MK 2 guidance system electronic packages. The Bureau contemplates award of contracts to Hughes Aircraft Corp., Culver City, Calif., and Raytheon Co., Sudbury, Mass. The equipment to be repaired on an "as required" basis, was manufactured by the above firms who possess special tooling and test equipment necessary to accomplish the work. This notice is for information only. PR No. SP-1560-64 and SP 1559-64. BuWeps Synopsis No. 313-64.

Aeronautical Systems Div.
Wright-Patterson AFB, Ohio
45433

Negotiations to be conducted with Lockheed Aircraft Co., Burbank, Calif., and North American Aviation, Inc., Downey, Calif., for follow-on chemical low-altitude missile program. RFP ASD-95656-ASZX. For information only, no RFP available.

Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio
44135

General Dynamics Corp., San Diego, Calif., is authorized under Contract No. NAS 3-3235 S/A No. 2 to procure ground-support equipment to activate government-owned combined systems test stand with the capability of electrically testing a combined *Atlas/Centaur/Surveyor* spacecraft system.

Office of Naval Research
Washington 25, D.C.

Negotiations are to be conducted with Thiokol Chemical Corp. for further research on the interaction of rocket exhaust under Contract No. 3543 (00). This is for information only, no RFP available.

Negotiations are to be conducted with Aero Geo Astro Corp., Alexandria, Va., for further research on the Delta Gamma program under Contract No. 4151(00). This is for information only, no RFP available.

Negotiations are to be conducted with Ford Motor Co., Aeronutronic Div., Newport Beach, Calif., for further research on the emission and absorption of infrared radiation under Contract No. 3560(00). This is for information only, no RFP available.

Air Force Flight Test Center
Directorate of Procurement FTKR-3
Edwards AFB, Calif.

This center contemplates awarding a contract to Motorola, Inc., for engineering services for extension of the AFFTC microwave system from Edwards AFB to the vicinity of Point Arguello, Calif. This procurement is a follow-on effort conducted by the contractor under AF Contracts Nos. 04(611)3742,8394 and 8528. Other proposals cannot be considered for this procurement.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Tex.

Solar still to be used in the *Gemini* survival kit for the conversion of salt water into fresh water. Job—RFP MSC-64-892P. RFP due date 12-18-63. RFP available until 12-10-63 unless supply exhausted earlier. Contract negotiator Tony C. Riggan, WA 8-2811, Ext. 7211, General Research Procurement Office.

NASA Issue Reprints Available Soon

Reprints of MISSILES AND ROCKETS' *Third Annual NASA Issue, which was first published Nov. 25, will be off the press soon.*

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ADVERTISING CLOSES: JANUARY 13, 1964

MICROELECTRONICS

PUBLICATION DATE: FEBRUARY 3, 1964

names in the news

George F. Mayforth: promoted to operations manager of the Singer Co., Metrics Div., Bridgeport, Conn.

Donald W. Douglas, Jr.: Elected chairman of the board of the Aerospace Industries Association of America, Inc., Washington, D.C. **J. L. Atwood** elected vice chairman and **Karl G. Harr, Jr.,** president.

Jerome L. Hanan: Appointed director of public relations and advertising, Europe, for Litton Industries, Inc., Beverly Hills, Calif.

Harrison F. Edwards: Vice president of Simmonds Precision Products, Inc., Tarrytown, N.Y., elected a director of the company.

Robert E. Stanaway: Appointed director of engineering and product development at Houdaille Industries, Inc., Buffalo, N.Y.

John L. Humbert: Appointed director of manufacturing operations of Belock Instrument Corp., College Point, N.Y.

Morris R. Lynn: Elected vice president of the operations division of Hycon Mfg. Co., Monrovia, Calif. **William Piper** elected financial vice president.

Leonard L. Roberts: Appointed manufacturing manager of the Controls Div. of the Leach Corp., Azusa, Calif.

Edward J. Rhoad: Appointed manager, Nucleonics Div., Hughes Aircraft Co., Fullerton, Calif.

Frederick J. Cudlipp: Appointed director of professional product marketing of CBS Laboratories, Stamford, Conn.

Charles E. Blakely: Promoted to director of engineering for the Tucson Research Laboratory of Textron's Bell Aerosystems Co.

Kenneth Jarmolow: Appointed director of the Martin Co.'s Institute for Advanced Studies, Baltimore.

Robert E. Sutherland: Named chief of professional placement and personnel at the Astronautics Div. of General Dynamics Corp., San Diego.

George M. McRoberts: Appointed manager of the Oceanic Products Div. of Aerojet-General Corp., Azusa, Calif.

F. Charles Ruling: Elected Atlantic Region vice president of General Electric Co., Washington, D.C.

Edgar H. Fey: Joined Lockheed Propulsion Co., Redlands, Calif., as senior technical specialist.

Kenneth Kasschau: Appointed manager of advanced projects at Westinghouse Electric Corp.'s Astronuclear Laboratory, Pittsburgh.

Francis R. Flood: Joined Raytheon Co.'s Semiconductor Div. as marketing manager, Mountain View, Calif.

Perry Pollins: Named marketing manager of Advanced Development Laboratories, Inc., Nashua, N.H.

David H. Simon: Appointed sales promotion manager for Electronic Specialty Co., Los Angeles.

Alva M. Hill: Appointed director of marketing of Gilfillan Corp., Los Angeles.

Len Gilmore: Named midwest regional sales manager for Texas Instruments, Inc.'s Industrial Products Group, Chicago.

E. R. "Bob" Champion: Appointed distributor sales manager of Spectrol Electronics Corp., San Gabriel, Calif.

Joseph A. Gentile: Appointed director of the Military Marketing Dept. of Motorola Semiconductor Products, Inc. Phoenix.

Nat Strunin: Named sales manager of Liberty Electronics Corp., Inglewood, Calif.

Samuel R. McConoughey: Named manager of military marketing for Ling-Temco-Vought's Continental Electronics Div., Dallas.

Raymond D. Griffiths: Appointed marketing manager for the western operation of Sylvania Electronic Systems Div. of Sylvania Electric Products, Inc., Mountain View, Calif.

Kenneth V. Tindall: Appointed systems sales manager for Gulton Industries, Inc., Metuchen, N.J.

Craig W. Hartsell: Named director of the configuration analysis program office in the Systems Research and Planning Div. of Aerospace Corp., El Segundo, Calif.

Marquis W. Bolton: Named director of engineering for American Nucleonics Corp., Calif.

Paul I. Grosher: Joined Space Ordnance Systems, Inc., El Segundo, Calif., as manager-contracts.

David W. Lang: Joined the Nortonics Div. of Northrop Corp., Anaheim, Calif., as executive advisor for special projects in the Systems Support Dept.

Bertrand R. Bertrando: Named director-system studies of the San Bernardino, Calif., operation of Aerospace Corp. **Robert D. Waldo** named director-defense systems studies.

Edmund M. DiGiulio: Appointed director of engineering of Mitchell Camera Corp., Glendale, Calif.

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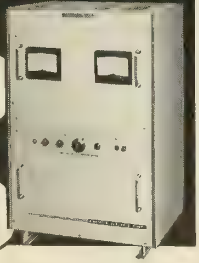

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—when and where—

DECEMBER

Florida Aerospace Industry Seminar, Cherry Plaza Hotel, Orlando, Fla., Dec. 3-4.

33rd Symposium on Shock Vibration and Associated Environments, U.S. Naval Research Laboratory, Washington, D.C., Dec. 3-5 (confidential).

Electronic Industries Association Winter Conference, Los Angeles, Dec. 3-5.

Testing of Manned Flight Systems Conference, sponsored by AIAA and NASA's Flight Research Center, Edwards AFB, Calif., Dec. 4-6 (semi-classified).

IEEE Ultrasonic Engineering Symposium, Marriott Motor Hotel, Washington, D.C., Dec. 4-6.

IEEE 14th National Conference on Vehicular Communications, Adolphus Hotel, Dallas, Dec. 5-6.

International Symposium on the Stability of Polymers, Battelle Memorial Institute, Columbus, Ohio, Dec. 5-6.

IEEE Fourth Annual Seminar on the Reliability of Space Vehicles, Airport Marina Hotel, Los Angeles, Dec. 6.

Nobel Festivities and Nobel Prize Ceremony, Stockholm, Sweden, Dec. 10.

Electronic Industries Association Microelectronics Conference, Philadelphia, Dec. 10-11.

SAE Committee Meeting on Spacecraft Flight Controls, Houston, Dec. 11-13.

AIAA Conference on Heterogeneous Combustion, Biltmore Hotel, Palm Beach, Fla., Dec. 11-13.

National Vendors Meeting, Space and Flight Equipment Associations, San Diego Aerospace Museum, San Diego, Calif., Dec. 13-14.

The 60th Anniversary of Powered Flight Observance Program, Kitty Hawk, N.C., Dec. 15-17.

Conference on Non-Linear Processes in the Ionosphere, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Dec. 16-17.

Wright Memorial Dinner, Sheraton Park Hotel, Washington, D.C., Dec. 17.

American Physical Society Meeting, Pasadena, Calif., Dec. 19-21.

American Astronomical Society Annual Meeting, College, Alaska, Dec. 26-28.

Third Western National Meeting, Space and Planetary Sciences sponsored by the American Geophysical Union, Boulder, Colo., Dec. 26-28.

NOTICE

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The Wall of Space

THE INDUSTRY must now make its adjustment to the advent of a new leader. The transition should not be a difficult one. The late President Kennedy has been succeeded by a man who is likely to press forward with a vigorous national space program.

Indeed, there is evidence that the late President himself was stepping up his support of the space program in recent weeks, particularly in regard to the need for a more active military role in this field. This momentum established by President Kennedy will be maintained by President Johnson.

Mr. Johnson, as Vice President, was, of course, head of the National Aeronautics and Space Council and one of the Administration's top policy makers on space matters. Until President Kennedy himself began to increase his public support for the space effort in the weeks before his death, Mr. Johnson was, in fact, the leading spokesman for the Administration in this field.

This is not to suggest that the late President was unenthusiastic in his backing of the space effort. Taking over from an Eisenhower Administration that did not grasp the significance of space to the nation's position in the world, to improvement of its technology or to its military protection, President Kennedy moved swiftly to regain the initiative from the Soviets. It became at once one of the most important of the New Frontiers. The nation owes to its vigorous young President a great debt—for his wisdom in grasping the importance of a strong space program, for his sense of our proper place in the future of the universe, for his actions to build U.S. strength in space.

We in this industry who mourn him must also share a pride in having played a part in one of his greatest contributions to his nation. We on this page were, at times, sharply critical of some of Mr. Kennedy's individual actions affecting the missile/space field. Yet, there is no praise too great for his overall accomplishment.

The late President left behind two speeches which were to have been delivered in Texas on the day when he was cut down by an assassin's bullets. Both displayed his strong interest in space affairs. As his last words in this field, they possess added significance.

This is part of the speech he was enroute to deliver when he was slain: "The success of our leadership is dependent upon respect for our mission in the world as well as our missiles—on a clearer recognition of the virtues of freedom as well as the evils of tyranny. And that is . . . why we have regained the initiative in the exploration of outer space—making an annual effort greater than the combined total of all space activities undertaken during the Fifties—launching more than 130 vehicles into Earth orbit—putting into actual operation valuable weather and communications satellites—and making it clear to all that the United States of America has no intention of finishing second in space.

"This effort is expensive—but it pays its own way, for freedom and for America. For there is no longer any fear in the Free World that a Communist lead in space will become a permanent assertion of supremacy and the basis of military superiority. There is no longer any doubt about the strength and skill of American science, American industry, American education and the American free enterprise system. In short, our national space effort represents a great gain in, and a great resource of, our national strength."

In his speech scheduled for that night in Austin, President Kennedy was to have warned of those who would see a less vigorous space effort: "We have made it clear to all that the United States of America has no intention of finishing second in outer space. . . . This is still a daring and dangerous frontier; and there are those who would prefer to turn back or to take a more timid stance."

His answer to such timid souls was best expressed in the speech which he delivered the previous day at Brooks Air Force Base. His words are indeed a legacy to the nation and to the industry: "This nation has tossed its cap over the wall of space—and we have no choice but to follow it. Whatever the difficulties, they must be overcome. Whatever the hazards, they must be guarded against. . . . With the help and support of all Americans, we will climb this wall with both safety and speed—and we shall then explore all the wonders and treasures that lie on the other side."

There can be no firmer instructions to those who follow him and who must continue to build on the foundations which the late President laid so well.

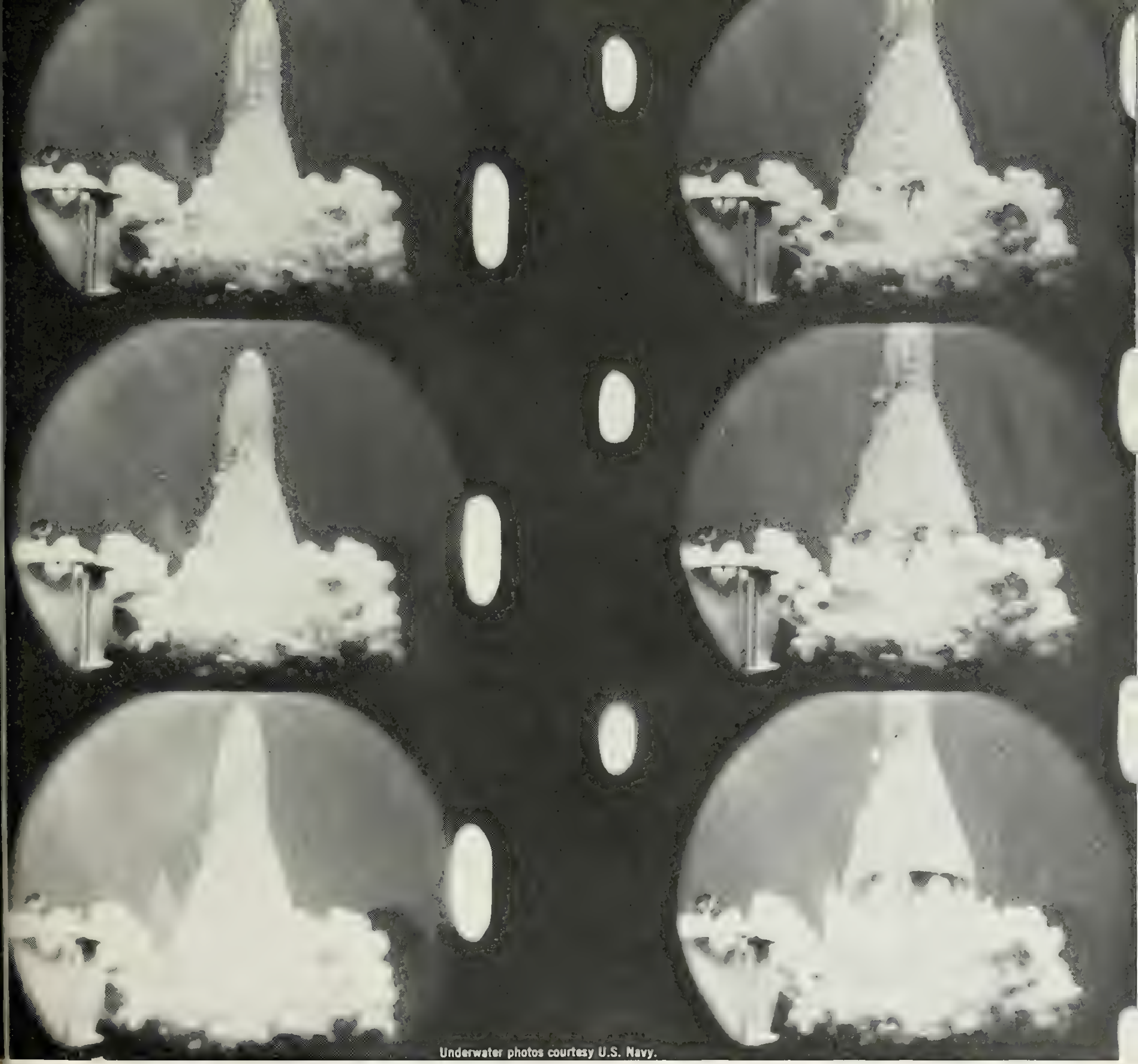
There will be many suggestions that public buildings be named after the late President, but we would like to support the suggestion that the new Administration, the Congress and the National Aeronautics and Space Administration consider naming the proposed NASA electronics research center the Kennedy Electronics Center to honor the man who set the course for the nation's great space venture. This would be particularly appropriate if, as seems most likely, the center is located in Massachusetts.

FOR OUR OWN farewell to this man on behalf of the industry, we repeat the words of the Senate chaplain, the Rev. Frederick Brown Harris, who delivered them as part of a prayer in the Senate chamber after word reached there that the President had been shot:

"We gaze at a vacant place against the sky as the President of the Republic goes down like a giant cedar, green with boughs, goes down with a great shout upon the hills and leaves a lonesome place against the sky."

And so it is.

William J. Coughlin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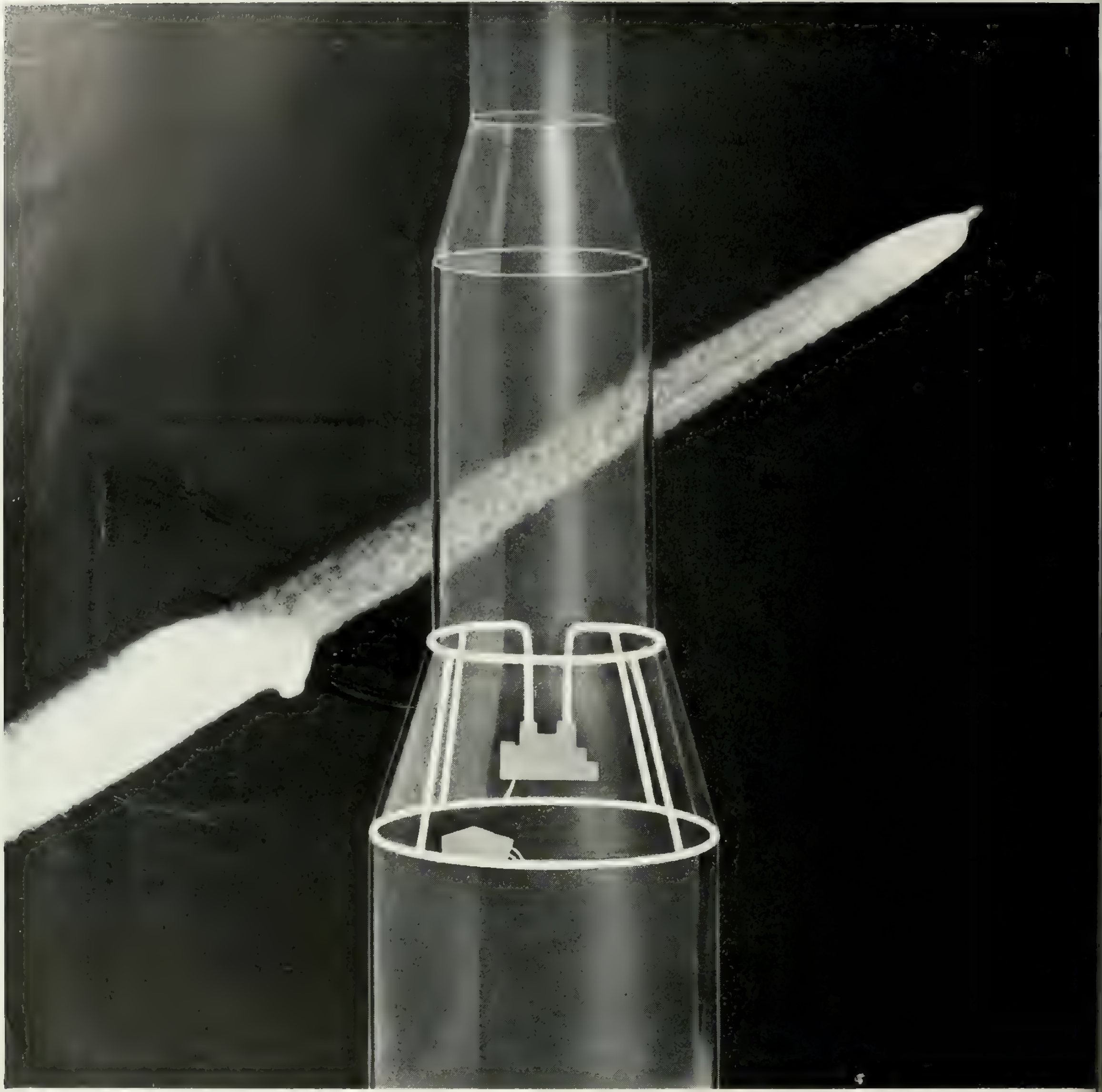

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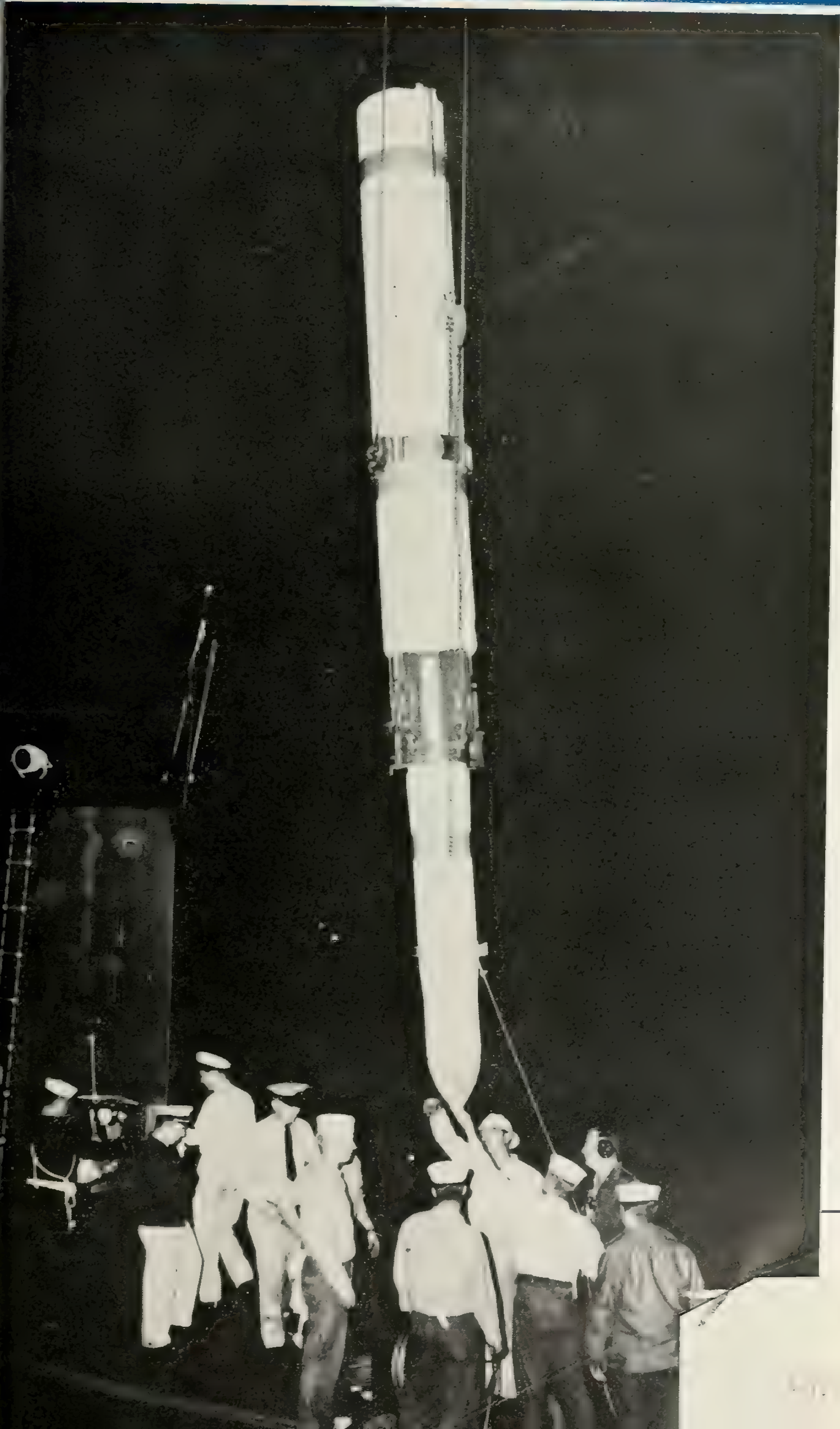

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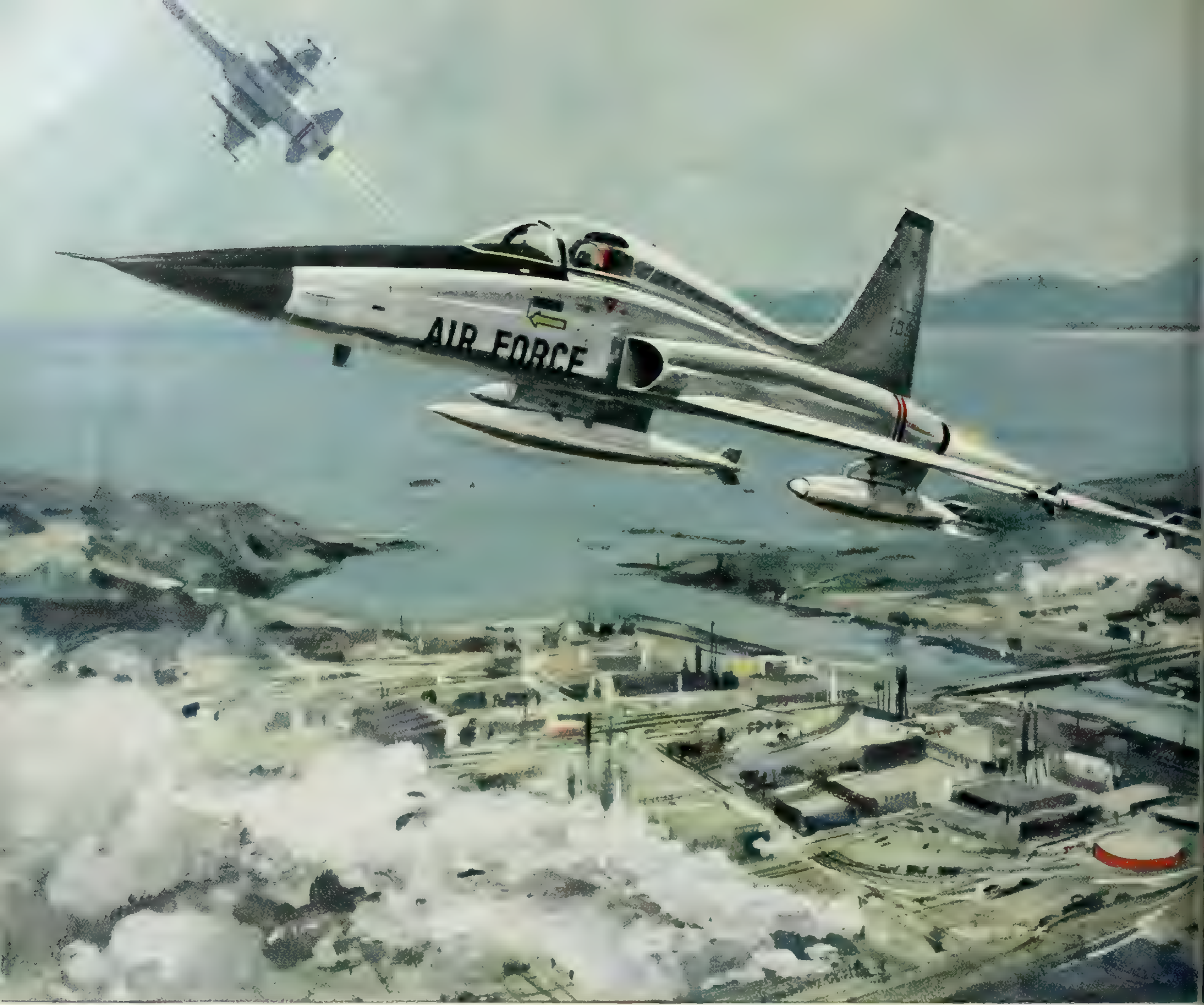

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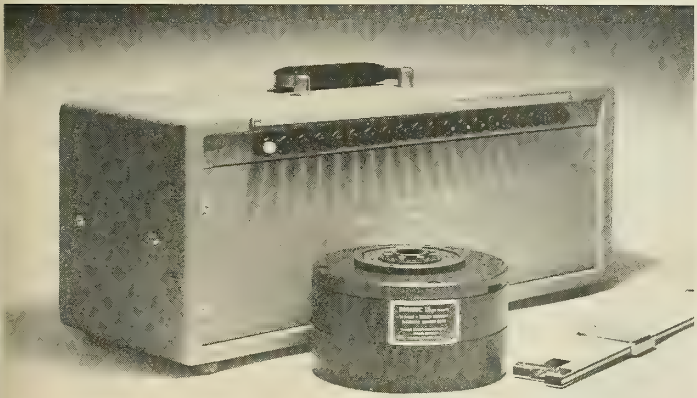

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5.5″	to 2 arcseconds
10″	to 1 arcsecond

Outputs available in decimal or natural binary codes. Accuracy is ±1 quantum, peak. For example a 2^{20} DIGISEC provides resolution of 1.24 arcseconds and accuracy of ±1.24 arcseconds, peak. Complete system consists of Optical Unit and Translator containing electronics and display. The standard Translator weighs 15 lbs., is 6.5″ x 17″ x 7.5″, and can be miniaturized. Total input power for standard system is 30 watts. Bulletin 6310-1.

ARCSEC™ Highest Accuracy Incremental Encoders

Similar to DIGISEC Encoders in resolution, accuracy and size of Optical Unit, but providing incremental output with reduced electronic complexity. Available with direction sensing and zero reset signal. Bulletin 6310-1.

DIGISYN® Direct Reading Encoders for tracking, navigation, sampled data servos, indexing and positioning systems, and other readout applications.

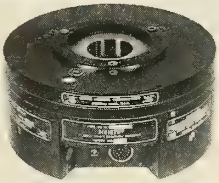
CYCLIC CODE

2^{10} to 2^{15} Digits
Case Diameter: 3.5″
Bulletin 760-1C

(photo: RD-15)

CYCLIC CODE

2^{16} to 2^{17} Digits
Case Diameter: 10″
Bulletin 162-1



(photo: RD-17)

NATURAL BINARY

2^{5} to 2^{17} Digits
Case Diameters: 2.625″ to 10″
Bulletin 6302-2

(photo: NB-10)

DIGITAK® Incremental Encoders for rate measurement, angle counting, machine control, inertial platform systems — available with direction sensing and zero reset signal.

MINIATURE SYNCHROMOUNT

2^{10} to 2^{12} Digits
Case Diameter: 1.437″
Bulletin 6212-1

(photo: RI-12M)

STANDARD SYNCHROMOUNT

2^{13} to 2^{15} Digits
Case Diameter: 3.5″
Bulletin 861-1C

(photo: RI-20K)

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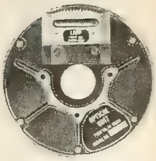
2^{13} to 2^{15} Digits
Case Diameter: 3.5″
Bulletin 862-2



(photo: RI-15S)

Special encoders can be designed to meet particular requirements. Available accessories include Power Supplies and Test and Display Sets. Other Wayne-George products include inertial test systems and fluid bearings.

WAYNE-GEORGE CORPORATION

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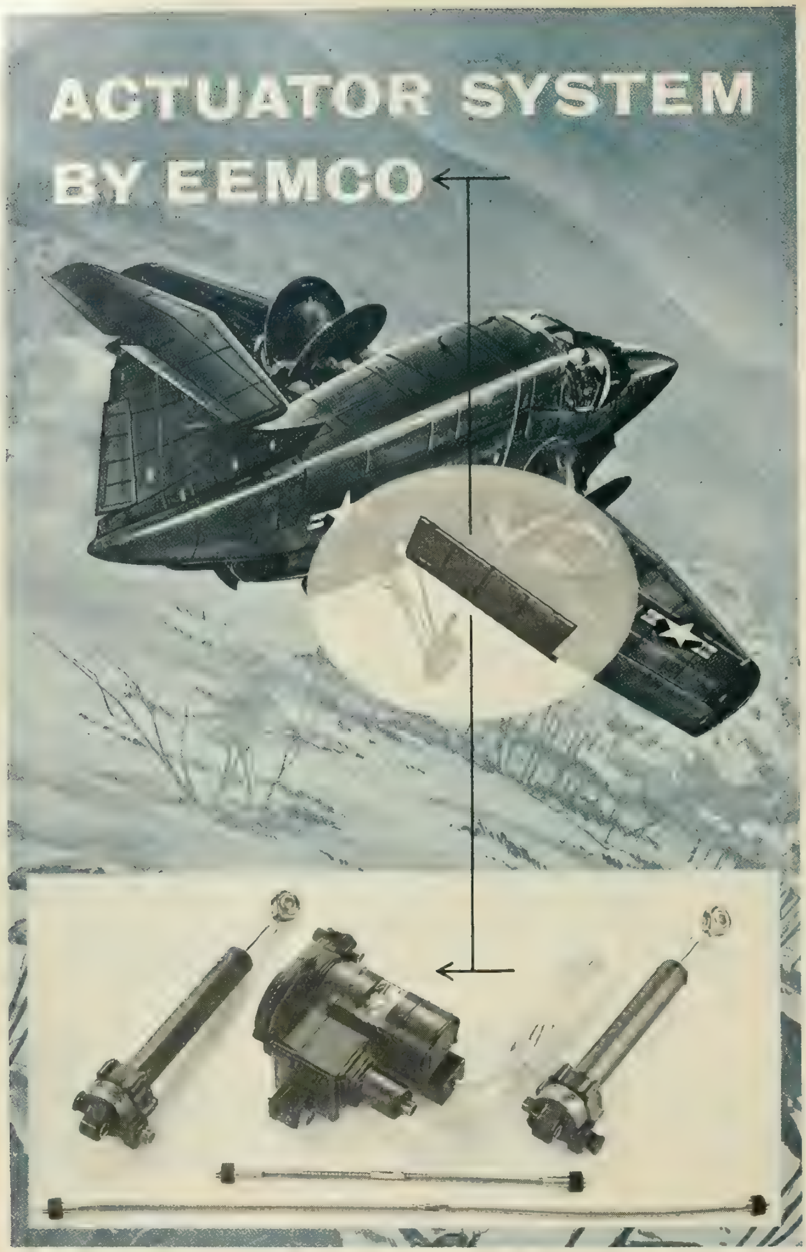

The vertical landing and take-off feature of the Army's XV-5A aircraft demanded a light weight, reliable, wing flap actuator system. EEMCO built it for Ryan Aeronautical Company, builders of the XV-5A, the world's first lift fan aircraft. ☐ The EEMCO flap actuator system is exceptionally light weight, 11.75 pounds, and consists of two ball-type screw jacks powered by a central drive unit through flexible shafting. The jacks are irreversible with non-jamming end stops. The drive unit is powered by a 28 volt DC motor having an electro-mechanical clutch and brake. Adjustable travel and interlock switches obtain an electrical stroke of 5.9 inches with an adjustment range of ± .25 inches. ☐ For further information on wing flap actuator system D 1518—or for information on motors and actuators for aerospace and industrial applications—write or call the EEMCO Division of Electronic Specialty.

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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 24 December 9, 1963

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THE COVER

Navy crew prepares to load a Subroc missile aboard U.S.S. Permit for one of recent 'highly successful' Pacific Ocean launches. The weapon is being developed by Goodyear Aerospace Corp. for Navy's BuWeps under technical direction of the Naval Ordnance Laboratory, White Oak, Md. See story, p. 12.

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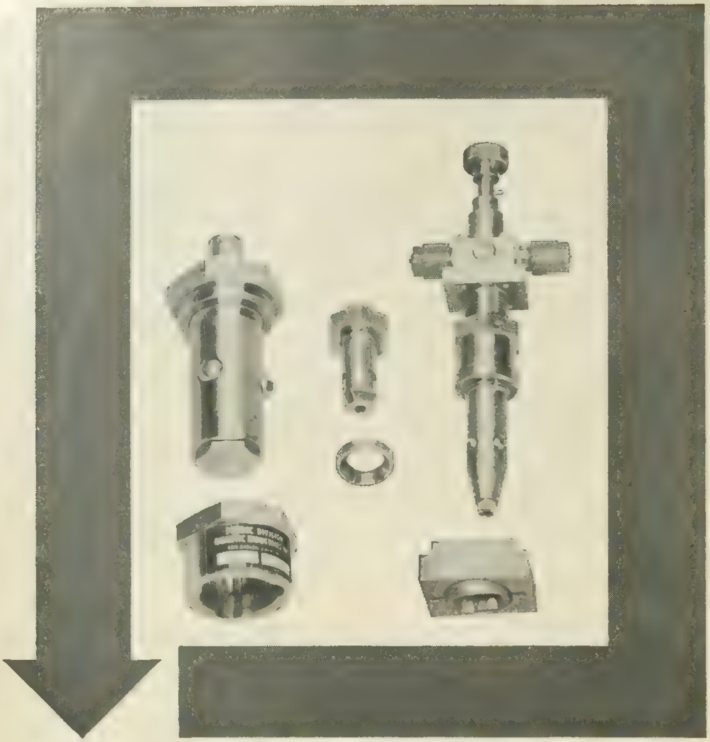


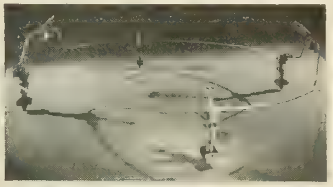
Our bolts are coming apart all over

Some products, when they begin to come apart in mid-air, can be awfully embarrassing. Not ours. They come apart on purpose. And gracefully.

Our Model 1102, for example. It has a record of 100% success in use on the (censored) ICBM re-entry vehicle. When the proper moment comes, it's just "click" and the vehicle sections separate according to program, with no fragmentation, no rupture or tearing of the skin, no release of gases, and no impulse to the separated section.

The Models 1020, 1046, and 1102 pyrotechnically-powered separation bolts shown above are widely used for separation, external stores ejection, and other applications requiring things to fall apart when actuated by an electrical signal. Similar separation bolts may be actuated hydraulically or mechanically. All are fragmentation-free, fast acting, and can be reloaded for re-use.

Send us an actuation signal by postcard and we'll separate some new data sheets from our application engineering department. We'll also send a general brochure on Pelmec separation systems, safing and arming units, and propellant actuated devices.



Pelmec ball-lock separation system used for re-entry vehicle separation.

PELMEC

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1015 Commercial Street
San Carlos, California

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letters

GE's Space Simulation

To the Editor:

Your article entitled "GE Test Simulates Orbiting Lab" (M/R, Nov. 18, p. 31) was by far the most complete and knowledgeable write-up of this work at our Valley Forge vacuum and space chamber.

We put a lot of effort into making this a really professional test, and we appreciate the very professional treatment you've given it.

Hilliard W. Paige
General Manager
Missile and Space Division
General Electric Co.
Philiadelphia

Message from Bombay

To the Editor:

This is to express our deep sense of regret and sympathy for the death of your country's great President Kennedy. With his premature death, the vital tasks of both national and international that were undertaken by him have abruptly come to a standstill, albeit that the new President has assured the world that he will continue in President Kennedy's footsteps diligently. His genuine interest in the welfare of the Afro-Asian countries ever since he became a Senator and till his untimely death as a President will bear ample testimony to his fighting courage in the service of humanity. In particular he aided our country with both men and materials for which we shall ever remain grateful. It should be heartening for you —Americans—to know that the spontaneous affection and gratitude to your *great President* was such in Bombay (in particular) that schools, colleges, commercial and industrial establishments, cinema houses and societies stopped work for a day, as a mark of profound sympathy for your dead President. This in brevity is our regard for your late President Kennedy.

His tackling of trying problems with immense courage and conviction, a hallmark in his career, was in itself a "Profile in Courage." The two lines from his last undelivered speech. . . . "The righteousness of cause must always underlie our strength. For it was written long ago: 'Except for the Lord keep the city, the watchman waketh but in vain'," are still ringing in my ears. Young as he was, he had many years ahead to further exhibit his latent ability, but the hands of death dealt a very cruel blow. It is only a consolation to bear with an adage that "Great Men die young."

In the space field too he did his best to push through many programs and was indeed unfortunate that he could not personally fulfill a promise to Dr. Von Braun of a free trip to Moon and back by 1970 and have it a *fait accompli.*

Summing up, we in India for years to come will cherish the memory of your *great President* John F. Kennedy as an ever-illuminating symbol of one who worked relentlessly and sincerely, often taking personal risks, towards peace.

R.V.S. Mani
Bombay, India

Gardner-Denver's Machine

To the Editor:

Your article entitled "Improved *Polaris* Fire-Control System Going to Sea Duty Shortly" (M/R, Nov. 4, p. 32) was read with interest by our people.

We did notice one technicality that we feel we should draw to your attention. The second paragraph on page 33 deals with the system's electronics. The last sentence states that General Electric reports that it developed a new programmed "Wire-Wrap" machine.

General Electric-Pittsfield purchased a standard Gardner-Denver automatic "Wire-Wrap" machine and put it in their plant to do this work. Please note that the words "Wire-Wrap" are the registered trademark of the Gardner-Denver Company. General Electric, as well as Control Data Corporation, did develop computer programs to make the punch cards to control this machine. Neither General Electric nor Computer Data had any involvement in the development of the automatic programmed "Wire-Wrap" machine.

The first machine of the specific type that General Electric and Control Data have was built for the SP-23 Group at the Bureau of Naval Weapons in Washington. This machine was similar to several other types that we had built, but it did have a slightly larger wrapping area and the grid was on a 0.2-in. grid, rather than 0.125-in. grid as were most of our prior machines.

D. P. Brouwer
"Wire-Wrap" Division
Gardner-Denver Company
Grand Haven, Mich.

Angular Velocity

To the Editor:

In letters to the editor of the Oct. 21 issue, R. W. Hogg brought out the fourth paragraph of my original letter (M/R, Oct. 14, p. 6), which was:

The old equation assumed the additional energy entered into the system. A mass revolving on the end of a cord showed up as increased kinetic energy when the cord's energy was reduced. The new definition indicates this is not true, so now we must ask ourselves: what happens to the energy entered into the system?

If Mr. Hogg would divide his circle into very small increments he would see that: 1) the increased tension is applied at right angles to the tangential velocity and 2) the path is getting *shorter*. I would respectfully ask, what is the mechanism to increase the kinetic energy of the mass?

If he will conduct the experiment and allow for the mass of the string and the friction of the system, he will discover that the kinetic energy never increases and, therefore, the small radius has a greater inertial potential energy than the large.

John W. Ecklin
Huntsville, Ala.

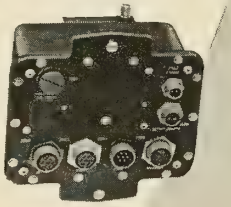
COMMAND PERFORMANCE!

by transistorized
RADIO CONTROL SET

Command flight control equipment by RS Electronics is setting new reliability standards. Remote control of the Navy's KD2R-5 drone shown here is achieved with RSE's Radio Receiving-Control Set which bears the MIL designation AN/ARW-79.

This set consists of an RSE Command Receiver Model 2624AT, proportional Decoder Model 1301A and Model 1805W Accessory Decoder if required.

These components comprise a single, compact airborne package designed and built for Northrop Corporation under U.S. Navy contract. This equipment combines solid state reliability with the packaging advantages of specially designed printed circuit boards.



Model 2624AT/1301A

Operated in conjunction with an airborne gyro to provide automatic flight stabilization, the unit will also control line-of-sight flights without the gyro. The basic package weighs only 4 lbs. 13 oz. and measures 7⅝" high x 7¼" wide x 5¼" deep.

In addition, RS Electronics can provide complete communications links for the remote control of pilotless aircraft and missiles. A typical link would consist of a coder, transmitter, airborne receiver and decoder.

For complete specifications on this Radio Control Set or other RSE equipment to satisfy special requirements, write to:

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RS ELECTRONICS CORPORATION
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ITT

The Countdown

WASHINGTON

Decision Near on Space Supplemental

President Johnson is expected to make an early decision—possibly this week—on whether to ask Congress for a supplemental NASA appropriation. The space agency has submitted a specific request to the Budget Bureau for a Fiscal '64 supplemental of $250 million. Chances for approval are very dim.

Lunar Orbiter Report Goes to Webb

NASA's source evaluation board has submitted its report on the *Lunar Orbiter* spacecraft competition to Administrator James Webb. Five firms are vying for the contract, part of a $150-million program.

Subroc Capable of Deep Launch

Thresher-class attack submarines will be able to fire the Goodyear *Subroc* missile from any depth in their operating range. Firing of the missile from maximum operating depth was not attempted during the 60 test launches off the California coast, however. Total cost of the *Subroc* R&D phase is expected to be $150 million. The R&D missiles cost about $200,000 each.

NASA Extends NavSat Contract

Researchers at Technology Audit Corp. are continuing to study possible use of a satellite as a navigation aid for advanced aircraft such as the supersonic transport. NASA originally contracted with RTC to study user needs, operational requirements and functional characteristics. Under a contract extension, the firm now is researching additional benefits to be derived from such a non-military system.

Fresh Air Force Interest in CLAM

Air Force interest in the *Chemical Low Altitude Missile* (*CLAM*), evidenced by a fresh announcement of earlier contracts to North American Aviation and Lockheed-California, is a setback for the *SLAM* nuclear low-altitude system. The $300,000 studies include preliminary design of a complete program for the system. *SLAM,* meanwhile is encountering technical difficulties.

GAO Recommends Defense PR Centralization

Consolidation of the public information functions of the military services under the Dept. of Defense public affairs office of Arthur Sylvester has been recommended by the General Accounting Office. Estimated financial saving: $1 million annually. Expected reaction of the services in comments due Dec. 16: negative.

Miller Praises Centaur Program

Rep. George Miller (D-Calif.), chairman of the House Space Committee, which has never hesitated to criticize the *Centaur* program in the past, now gives it unqualified praise. He also feels the General Accounting Office report attributing a $100-million loss to *Centaur* is misleading. Some $76 million of that amount is attributable to *Advent,* cancelled in 1962 when the satellite already was far in excess of *Centaur's* most optimistic predicted payload.

Stevenson Renews Lunar Proposal

Ambassador Adlai Stevenson has renewed in the United Nations the proposal of the late President Kennedy for a joint Soviet-American lunar program (COUNTDOWN, Dec. 2, p. 7). There still has been no formal response to the proposal.

Two NASA Launches Still Set

Two NASA launches still are set from Cape Kennedy in December—*Tiros 8* on Dec. 17 and *Saturn SA-5* on Dec. 18. *Tiros* will not employ the new X-258 third stage but will use the X-248 stage used in past *Delta* launches. This is attributed to the fact that *Tiros* doesn't need the extra boost, not to malfunctions blamed for the foreshortened orbit of the recently launched *IMP* satellite.

INDUSTRY

New Research Facility Is Dedicated

Air Force Electronics System Division and Mitre Corp. formally dedicated a new Systems Design Laboratory at Cambridge, Mass., last week. Key unit of the facility is an IBM 7030 computer.

Cape Kennedy Legality Questioned

Naming of the Cape Canaveral missile space center for the late President Kennedy met universal approval in the area. But the decision to change the name of the Cape itself to Cape Kennedy was received with frigid hostility by some residents. State Senator Bernard Parrish, who represents the county surrounding the Cape, believed to have been named by Ponce de Leon in 1513, has raised a legal question about the change. He says such action legally can be taken only by the state legislature.

INTERNATIONAL

French CT-41 Is Flown Successfully

Nord Aviation has announced a test of its *CT-41* target missile at the Hammaguir range on Nov. 23 which reached Mach 1.8 and made a 180-deg. turn during a successful six-minute flight.

British Photo of Red Missile Is Hoax

A photograph published in the weekly British aviation magazine *Flight* on Nov. 28 and said to show a secret Soviet air-to-air missile during launch from a MIG-23 has been revealed as a hoax. The photo was sent to the magazine by a British schoolboy who faked it.

French Open Inertial Lab

A laboratory for the development of inertial guidance systems has just been opened by the French at Vernon (Eure). Work initially will be concentrated on development of inertial guidance systems for the *SSBS* and *MSBS* missiles.

STL NEW PROPULSION OPPORTUNITIES

In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

Requirements include a degree in engineering or science with appropriate experience.

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Experience in the design, development or testing of liquid propellant propulsion systems, rocket engines, feed system components, thrust chambers, injectors and thrust vector controls.

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The Missile/Space Week

Eruptions Seen on Moon

Volcanic eruptions have been spotted on the Moon's surface according to the Lowell Observatory. The observatory reports that the first eruption was viewed through its telescope on Nov. 27 and lasted approximately 85 minutes. Three others were reported on Nov. 29, lasting approximately 20 minutes.

Observers included James Greenacre, Edward Barr and Dr. John S. Hall, director of the observatory. All the eruptions occurred around Aristarcous.

Greenacre has watched the lunar surface almost every night for three years as part of the Air Force chart institute's work of mapping the surface of the Moon for NASA.

The Lowell report tends to support the first such documented observation, made on Nov. 3, 1958, by a leading Russian astronomer, M. A. Kovyrev. Kovyrev wrote at the time, "We took a spectrogram exposed from 3:00 to 3:30 (U.T.) showing fluorescence of gases issuing from the center of Alphonsus."

A portion of the scientific community has remained skeptical of the Russian's observation, however.

Explorer 18 Working Well

Explorer 18, NASA's interplanetary monitoring probe (IMP) satellite, is sending back valuable data even though it fell about 50,000 miles short of its intended apogee.

The space agency said the satellite achieved an apogee of 122,800 mi., had a perigee of 119 mi., and had completed its second orbit Dec. 4. It was launched from Cape Kennedy Nov. 26.

NASA said all systems appeared to be working as planned in relaying information on the solar radiation *Apollo* astronauts will encounter.

AF Gets Titan III Engines

Air Force Space Systems Div. has accepted the first- and second-stage liquid rocket engines for the first *Titan III-A* launch vehicle from Aerojet-General Corp. The powerplants—improved versions of the *Titan II* engines—will be shipped to Martin Co.'s Denver facility where they will be installed in the first flight test model of the spacecraft, scheduled for launch from Cape Kennedy during the third quarter of next year.

Delivery of the flight test models of the *Titan III* transtage motors, also being developed by Aerojet-General for SSD, is slated for next year. A twin-barrel, pressure-fed engine developing 16,000 lbs. of thrust at altitude, the transtage propulsion system will have a multiple re-start capability. All three systems use noncryogenic hypergolic fuels, eliminating the need for a complicated ignition system.

Shots of the Week

The Air Force launched two *Minuteman* missiles last week from Vandenberg AFB, Calif. The firings, one on Nov. 27 and the other on the 29th, were termed "routine training missions." Launchings were successful, but information as to the accuracy of the shots was not released.

- NASA's *X-15* rocket plane was flown to an altitude of 92,000 ft. Nov. 27 by test pilot Milt Thompson. The flight, second for Thompson in the *X-15,* was to familiarize him with extreme altitude control of the craft. Thompson reached a top speed of 3,100 mph.
- A *Polaris A-3* missile launched at night Nov. 26 from the deck of the Observation Island missile support ship was destroyed by the range safety officer 52 seconds after launch when it wandered off course.

J-2 Fired 500 Seconds

The liquid hydrogen J-2 engine was successfully test-fired recently for over 500 seconds—or more than eight minutes.

The Nov. 27 test, first long-duration firing of the J-2, appeared to meet all its objectives and was considered a major milestone in the development program.

The engine is being developed by Rocketdyne, a division of North American Aviation, Inc., under the technical direction of NASA's Marshall Space Flight Center. Originally designed to operate for 250 seconds, the J-2 was extended to 500 seconds of flight operating time late last year. Tests at the shorter duration have been under way since October, 1962.

A single J-2 will power the S-IVB upper stage being developed by the Douglas Aircraft Co.'s Missile and Space Systems Div. for the *Saturn IV* and *Saturn V* vehicles.

A cluster of five J-2 engines developing 1,000,000 pounds of thrust will power the S-II stage under development by North American's Space and Information Systems Div. for *Saturn V*.

Launch Simulator Award Let

Goddard Space Flight Center is negotiating with the Marine Engineering Dept. of Northrop Corp.'s Nortronics Div. for design and construction of a huge test device to simulate the launch phase of space flight.

Estimated cost of the contract is $1.9 million.

Called a Launch Phase Simulator (LPS), the device will test unmanned spaceflight units and components under the separate or combined conditions of acceleration, vibration, noise and vacuum.

The 230-ton test device will consist of a controlled-environment test chamber mounted on one end of a counter-balanced rotating arm. It will have a 60-ft. test radius.

Spaceflight units weighing up to ,000 lbs. and measuring 10 ft. in liameter by 15 ft. in length will be ested in the chamber.

A separate contract will be nego-iated in the near future for a 2,500-ıp dc drive system to rotate the arm ınd test chamber up to 34 rpm.

anaveral Now Cape Kennedy

President Johnson, at the end of ıis Thanksgiving Day message to the ıation, announced that Cape Ca-ıaveral and NASA's Station No. 1 f the Atlantic Missile Range and ts Launch Operations Center will ıenceforth be known as Cape Ken-ıedy and the John F. Kennedy Space enter, respectively.

ermany to Sell Rockets

Testing of four West German-eveloped military rockets was sched-lled in Germany late last week as a relude to that nation's Aviation Ar-ıament Corp.'s offering the rockets r sale.

Joachim Boegner, chairman of the amburg firm, said Aviation Arma-ıent will sell the rockets to any non-ommunist country that can pay for ıem.

The rockets will be produced in nall numbers and will be sold only r export. They are designed to ırry very small payloads over short istances, or to reach altitudes of out 90,000 ft.

Some 40 military rocket experts om several nations were scheduled witness last week's demonstra-ons.

Radiometric, Correlation & Communications Engineers

HONEST
DATA
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here
and
here

to provide reliable, rapid information about space vehicle performance along the 10,000 mile length of the Atlantic Missile Range is the prime responsibility of Data Support Engineers with Pan Am's Guided Missiles Range Division.

Their mission is to plan new instrumentation systems and develop system specifications in such information areas as: frequency control and analysis, command systems, television systems, interference analysis, timing and firing systems, recovery aids, and communications and underwater sound systems.

A look at 3 of over 30 current projects will indicate the scope of the operation:

☐ development of a new range instrumentation control system utilizing 3-kc K-carrier circuits which will reduce the response time and increase the data handling capacity of switching circuits between Cape Canaveral and downrange stations.

☐ improvement of precise digital timing generators and terminal shaping equipment so that correlation uncertainty across the Range will be less than 100 μsecs.

☐ installation of a new submarine cable between Cape Canaveral and Antigua to increase voice and telemetry data transmission capability.

Radiometric, Correlation, and Communications Engineers with EE or Physics Degree and applicable experience will find unusual diversity in the data support projects undertaken at the Atlantic Missile Range.

Address inquiries in confidence to
Mr. Raymond V. Godfrey, Manager—Range Development, Dept. 56 M-2.

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Early next year . . .

Subroc Faces Operational Tests

Navy describes recent Pacific shot series as 'highly successful'; estimated 200 missiles in first Goodyear Aerospace production run

NEW YORK—Encouraged by a "highly successful series of tests" in the Pacific, the Navy expects to move into the operational evaluation stage with the submarine-launched *Subroc* anti-submarine weapons system early next year.

The USS Permit, sister ship to the ill-fated Thresher, conducted most of the Pacific tests. The shots were made with prototype production engineering versions of the missile from all depths and to its maximum range.

About 30 operational-type missiles will be involved in the next stage of testing. This series should be completed next year, just before the expected operational deployment of the missiles. None of these versions has yet been delivered, and contractors will probably proceed with the building of fleet units during the final test period.

Subroc production is tied to production of the 594 class of nuclear-powered attack submarines for which they are designed.

Each sub of this type has four torpedo tubes and can carry about 24 torpedos. Actual weapon load figures are classified, but the *Subroc* is fired from a conventional torpedo tube and is restricted in dimensions to those of a standard torpedo. The number aboard any given boat would vary depending on missions, but the Navy says a torpedo/*Subroc* mix is most likely.

- **Production estimates**—Observers close to the program estimate a complement of four to six *Subrocs* per sub, which indicates about 200 missiles in the first production run. The cost of the *Subroc* program through completion of the planned buy is set at $200 million—exclusive of the cost for the vessels and certain shipboard gear.

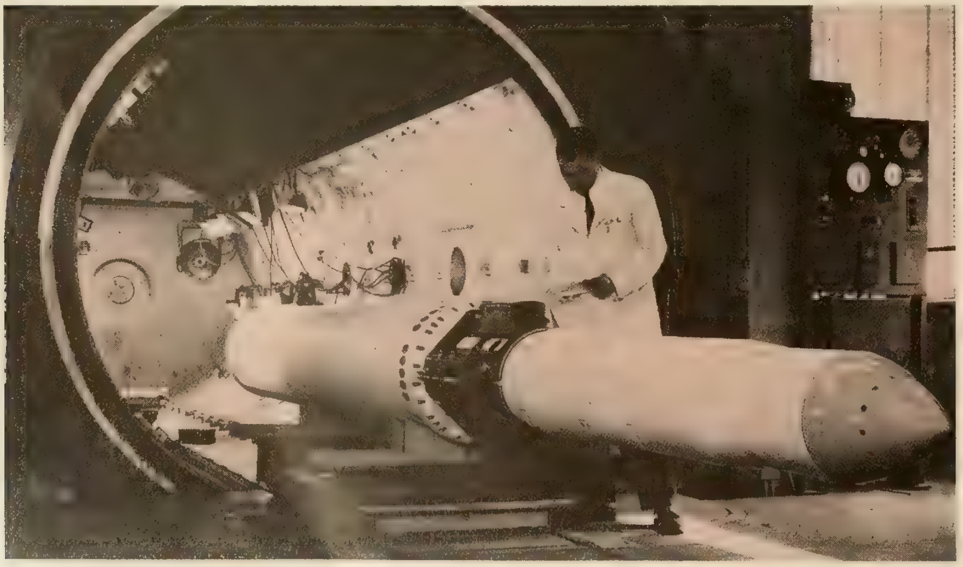
Details of the *Subroc* program were revealed by the Navy and Goodyear Aerospace Corp., prime contractor, at a New York press conference last week. In addition, representatives of Librascope and Aerospace Divisions of General Precision, Inc., Thiokol Chemical Corp. and the AiResearch Div. of the Garrett Corp. were present.

Conspicuously absent from the conference was the Raytheon Co., developers of the high-performance AN/BQQ- sonar system—the most critical elemen of the entire *Subroc* weapons system Other industry officials present expressed surprise at this omission. On top executive told MISSILES AND ROCKETS that the entire *Subroc* developmen hung on the ability to develop a sona system capable of complementing th missile's long range.

The reason for the lack of Raytheo participation apparently was that th sonar development was undertaken b the Bureau of Ships as part of the ship' structure rather than as an integral uni in the weapons system.

It was also learned that the sona was not developed exclusively for *Subroc*—though it was certainly in mind—but rather as an advanced system capable of handling all other ASW weapon

Navy officials said the service is i



LEFT: Underwat pressure tests a conducted in th chamber at NO White Oak. O POSITE PAG Sequence show test firing of Su roc weapon syste

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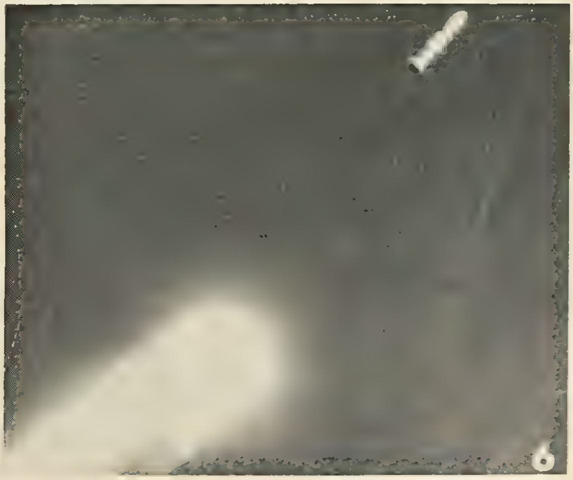
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vestigating putting the very-long-range sonar system the *Subroc* requires aboard a surface ship. "We could have one—the sonar—in the very near future," according to one Navy man.

The *Subroc's* operational range is classified—but speculation has pegged it at between 30 and 50 miles. The range is known to be greater than all other ASW weapons except aircraft. Maximum range is dependent on the depth of launch.

• **How it works**—in operation, the ASW weapon is ejected from conventional torpedo tubes at depth. The launching vessel need not be pointed at the target. The solid motor ignites underwater a safe distance from the submarine, boosting the weapon out of the sea towards the submerged target at supersonic speeds.

The booster unit separates from the nuclear depth charge at a pre-determined velocity through thrust-reversal techniques. Jetavators control the missile while in powered flight by deflecting the exhaust gases on command from the guidance system.

After booster separation, the depth bomb flight is controlled by aerodynamic fins in response to the guidance system. Water impact is cushioned through a special shock-mitigating system. The nuclear charge then sinks to a programmed depth and detonates.

The General Precision underwater fire-control system, Mark 113, is a highly accurate, rapid, digitalized unit. Since the basic design is modular, the system can be modified easily to fit the needs of various submarines. The Mark 113 can handle other submarine-launched weapons in addition to the *Subroc*.

The rest of the complex weapons system includes advanced sonar for detecting and tracking ships and submarines at long range.

- **Propulsion system**—The *Subroc* uses a Thiokol-formulated polyurethane/ammonium perchlorate case-bonded propellant. The outer diameter of the booster is within the 21-in. maximum limit of conventional submarine torpedo tubes.

The cylindrical motor case has a duel forward bulkhead design incorporating the thrust-reversal system and an aft bulkhead containing four nozzles, each equipped with a jetavator thrust-vector-control system.

Six cable-carrying conduits that run down the length of the case's inside wall posed a problem to Thiokol grain designers. The propellant burns around these conduits without damaging them. The grain acts as insulation.

The presence of the conduits imposed unusual stress problems within the propellant charge. The Thiokol grain design handles this over the lengthy tactical storage temperature requirements for *Subroc*.

The *Subroc* propellant combines a high specific impulse with a low burning rate.

Once the *Subroc* is in its tube and made ready, the missile can be launched in less than one minute. After *Subroc* is expelled, there is at least a 1-sec. delay before motor ignition can take place. The igniter is a hot-wire squib arrangement mounted in a rotating shutter safe-arm device, M/R was told.

A pre-programmed command signal is used to initiate thrust reversal after the missile has flown its prescribed powered trajectory. The command fires explosive bolts that release clamps, which, in turn, allow a piston at the head of the motor to move rapidly forward.

This permits gases to rush into a plenum cavity and blow thrust reversal plugs uniformly to avoid undesirable torque effects. The thrust reversal, which reportedly can be accomplished right up until tail-off phase of flight, is rated at about one and one-half times the normal thrust of the motor, allowing the forward acceleration of the nuclear depth bomb to pull free, breaking a 200-pin connector.

- **Guidance problems**—The guidance and control problems associated with *Subroc* are unique. The 4,000-lb. vehicle must be launched initially in the horizontal position from a standard torpedo tube. After expulsion from the launching submarine, the rocket is ignited and the G&C system takes over.

The problem of greatest concern is providing the capability to guide and control the weapon through sea water from varying depths, over a variable surface path in the atmosphere, and then—after separation of the depth-charge warhead—to effect proper water re-entry angle.

Guidance is three-axis inertial, control is thrust vectoring, and computation for G&C is digital.

Aboard the submarine, a digital fire-control system provides all the necessary pre-launch programming inputs to the *Subroc* computer. Principal fire-control data sources include target information and ship's position and motion information.

Built by Aerospace Div. of General Precision, Inc., the inertial guidance stable platform is a three-gimbal system employing three floated single-degree-of-freedom rate integrating gyros mounted on the azimuth or inner gimbal. Three force-balance pendulous accelerometers, also located within the center gimbal, provide three-axis detection of motion-change or acceleration forces acting on the vehicle.

Platform electronic subsystems are all-modularized and potted.

- **Fire-control critical**—The underwater fire-control system, built by GPI's Librascope Div., is modularized and is readily adaptable for installation in almost any specific U.S. submarine.

The Mk 113 is capable of processing data from up to eight different sensors. Target data sources include radar, long-range sonar and periscope, while other inputs are derived from the Ship's Inertial Navigation System, an electromagnetic log, a dead-reckoning analyzer indicator and a depth indicator.

Engineers developing the fire-control system point to the introduction of the digital computer portion of the FC as the key to being able to achieve the improved accuracy at longer ranges while keeping production costs down. The computer system, though primarily digital, is actually a hybrid, containing some analog elements.

The GPI Mk 113 underwater control system attacks an essentially different problem, that of a moving target, than the newly introduced Mk 84 digital fire-control system for *Polaris*. Engineers say the extended range of the system and the need for improved accuracy presented the biggest need for improvement in existing capabilities, while the peculiar environmental problems of targeting were also taxing, but probably not as technically difficult.

At heart of the Mk 113 FC system is the new Mk 130 general purpose solid-state digital computer developed by GPI specially for military applications. The device has a medium-speed, random-access magnetic core memory system with a storage capability of 4,096 20-bit words. Memory read-write cycle time is 20 microseconds, and data-availability time is 7 microseconds after zero time.

Five analog computers support the Mk 130 for special computing and control functions.

- **Missile APU**—AiResearch Manufacturing Div. of the Garrett Corp., developer of the *Subroc* on-board auxiliary power unit (APU), claims its power system is the most sophisticated ever built for a guided missile.

All power to the vehicle from pre-launch to water re-entry is provided by the solid-propellant-fueled APU. A hydraulic servo control system also is provided by AiResearch for mechanical positioning of the aerodynamic control surfaces. Both systems are located in the depth-charge (last stage). Together, the systems are called the Control and Auxiliary Power Supply or CAPS.

Before launch, CAPS accepts shipboard ac power and converts it to regulated ac and dc power for the missile guidance and steering control system for checkout. During flight, CAPS generates all necesasry internal electrical power. Also, in response to G&C commands, it moves and positions the aerodynamic control surfaces.

The design approach to CAPS is unique, according to AiResearch, in that it combines in one major subsystem, all the guidance system electrical control circuits necessary to hold electric power at the required quality level, plus the hydraulic actuation and steering components—none of which is normally a part of an APU.

The approach, developers disclosed, has paid off in reduced costs, test and checkout complexity, checkout time, maintenance and parts provisioning (resulting from the overall components integration). ■

First new liquid in decade . . .

Centaur Flight Hailed as Successful

by Chris Butler

NASA's *Atlas-Centaur-2* launch is credited by the space agency with achievement of all flight objectives despite premature loss of telemetry and evidence that some components separated in orbit from the liquid hydrogen stage.

Space agency officials blamed battery failure for the telemetry loss during the Nov. 27 flight from Cape Kennedy.

The four objects surrounding the orbiting *Centaur,* they said, are believed to be insulation panels and the nose fairing. Officials theorized that they dropped off *Centaur* when the venting of gaseous hydrogen forced the stage to tumble in space.

This is not expected to present a problem during *Centaur* operational missions. For its *Surveyor* missions, *Centaur* will not go into orbit, but will go by direct ascent to the lunar surface. The insulation panels and the nose fairing will be jettisoned prior to achieving escape velocity.

Telemetry returns were described as excellent during the early part of the flight along the Atlantic Missile Range chain of tracking stations. Signals were picked up by the Deep Space Network stations in Johannesburg, South Africa, and Woomera, Australia. The signals were fading by the time *Centaur* passed over Australia and some faint signals were picked up by the network station at Goldstone, Calif.

A detailed study of telemetry tapes will be required to pinpoint what caused the loss of signals.

Engineers and scientists had planned for 10 hours of battery life and extensive returns of telemetry data—326 measurements over five telemetry systems—from the second stage and nose fairing, which achieved an orbit of 340-1,050 mi., a figure that varied only slightly from the planned 345-1,035 mi.

A review of *Atlas-Centaur* performance indicated the entire flight as a triumph for the programmer-autopilot which put the two-stage, General Dynamics/Astronautics space booster precisely on target.

- **Propulsion**—Flight data revealed that nearly every phase of the operation approximated planned performance. Planned and actual performances were:

	Planned	Actual
Booster engine cutoff	150 secs.	149.9 secs.
Staging	153 "	152.8 "
Sustainer Engine cutoff	229 "	227.2 "
Separation	235 "	228.8 "
Centaur ignition	245 "	245.2 "
Centaur engine cutoff	625 "	623.4 "

At the time of cutoff, the *Centaur* stage was traveling 24,302 ft./sec. About 10% of the propellants were left in the stage at cutoff, possibly enough to have permitted *Centaur* to reach escape velocity if the engines had run until propellants were exhausted. There was no indication whether a full load of propellants was carried.

LIFTOFF of Atlas-Centaur-2 Nov. 27.

The Pratt & Whitney RL-10A3 liquid hydrogen engines, which were ignited for the first time in space, met all expectations and provided a specific impulse of 427 secs. It was the first use of a new liquid fuel in a U.S. rocket in 10 years.

- **Guidance**—The flight also provided the first evaluation in space of the guidance system which eventually will control all *Centaur* flights. The Minneapolis-Honeywell-built system, first all-inertial guidance system developed for space missions, is built around a four-gimballed stable platform incorporating three integrating gyros and three pendulous accelerometers. The system works with a specially designed Librascope computer.

The system, which flew open-loop on *AC-2,* was monitored by telemetry to assess performance against measurements made by Azusa and elements of the Glo-Trac system recently installed on the Atlantic Missile Range by General Dynamics.

The flight also produced several other space "firsts," including the initial successful flight for the straight-side *Atlas* and the strengthened *Centaur* stage, the first major test of the Glo-Trac system and the initial flight of the redesigned weather shield which has been blamed for failure of the first *Centaur* flight on May 8, 1962.

- **Improvements**—Preflight briefers from Goddard Space Flight Center, which directed the launch, and Lewis Research Center, management agency for *Centaur,* said the weather shield that joins the nose fairing with upper-stage insulation panels ruptured on the *AC-1* because it encountered lower external pressures than expected.

The weather shield, nose fairing and insulation panels used on the Nov. 27 flight remained with the *Centaur* stage and went into orbit. On future flights, the nose fairing and the insulation panels will be jettisoned during powered flight after passing through the area of aerodynamic heating.

Redesigned panels and fairings have been fabricated and are being tested. *Atlas-Centaur AC-3,* now scheduled for launch next March, will carry a nose fairing 5 ft. longer than the model carried on *AC-2.* It will duplicate the fairing which will protect a *Surveyor.*

Dynamic models of the *Surveyor* are scheduled to ride *Centaurs AC-5* and *AC-6* to study effects of *Surveyor* loading on the *Centaur* stage.

A total of six more research and development vehicles and seven operational *Atlas-Centaurs* now are included in the program, which has cost $325 million to date and will run $535 million for vehicles and facilities before it ends. After that, operational models will cost $11.5 million each.

- **Through the hole**—The *AC-2* flight was delayed one day by the death of President Kennedy and was nearly postponed again by weather.

Optical coverage was a prerequisite, and a heavy overcast blanketed Cape Kennedy Nov. 27 until the launch at 2:03 p. m. Search planes found a large "hole" in the overcast near Tampa at mid-morning and followed its progress eastward. The rate and direction of movement was plotted and the countdown was resumed in time to coincide with arrival of the clear sky. ■

For the moment . . .

White House Blocks Apollo Slowdown

NASA directive to contractors apparently was stopped pending Administration decision on FY '64 supplemental request

by Hal Taylor

THE WHITE HOUSE last week killed a NASA directive which was to have ordered a work slowdown by Project *Apollo* contractors pending a reassessment of the U.S. manned spaceflight program.

The White House move is expected to be only a temporary delay. NASA action to implement the directive is imminent.

Informed sources report that top space agency officials prepared a press release on Dec. 6 which announced that the $250-million budget reduction in Fiscal Year 1964 would have to come out of planned Project *Apollo* funding.

At the same time, telegrams to the prime contractors in the program were prepared. The telegrams ordered the firms not to expand, hire new employees or spend money which the space agency had earlier indicated would be available on the basis of the agency's $3.5-billion FY 1964 authorization request.

The slowdown, the telegrams said, would continue until a "reassessment of the manned space flight program is completed." Informed sources report that the study probably will not be finished until early next year.

• **Off again**—Just as the announcement of the directive was to be made, NASA officials suddenly declared there would be no public release. They refused to give a reason, but informed sources told MISSILES AND ROCKETS that the White House had intervened.

The White House apparently stopped execution of the directive because of current Johnson Administration consideration of the space agency's request for a supplemental FY '64 appropriation of $250 million which NASA recently submitted to the Bureau of the Budget.

A decision as to whether the request will be submitted to Congress was expected late last week or early this week. White House officials, the sources said, believed that the directive to the contractors should be delayed until the supplemental decision had been made.

They also may have felt that the NASA release which would have accompanied the directive might have been intended to gain public sympathy and support for the space agency's desire for additional money in the current fiscal year.

Reportedly, the new Administration is opposed to the new request and the chances for approval of the supplemental are very slim. This stems not only from the Administration's reluctance to ask Congress to reconsider the space agency program, on which it is now winding up action, but also from President Lyndon B. Johnson's plea for agencies to hold down spending.

In his first speech to Congress, the President pledged that under his Administration "the expenditures of government will be administered with the utmost thrift and frugality."

The same penny-pinching may have a sharp effect on the space agency's Fiscal '65 budget request, which also is under discussion with Budget Bureau officials. There are unconfirmed reports that President Johnson has asked the agency to reduce its request for the next fiscal year by some $200 million.

Administrator James E. Webb has declared that the space agency must have $5.6-5.8 billion if the U.S. is to meet the Project *Apollo* schedule calling for a manned lunar landing before the end of the decade.

Administration officials are said to be determined to hold the Fiscal '65 budget below $5.5 billion. The comparative modesty of that amount, plus the absence of a supplemental appropriation for this year, could put a severe crimp in the agency's manned and unmanned space flight programs.

If the supplemental request is denied, it will kill for the present NASA plans to develop several backup systems for Project *Apollo*. ■

AF School Makes Pitch To Train All Astronauts

EDWARDS AFB, CALIF.—The military—specifically the Air Force's Aerospace Research Pilot School—should train all U.S. astronauts, claim two ARPS officers.

William G. Schweikhard and Lt. Col. Robert S. Buchanan observed at a meeting here last week that even the civilian test pilots picked by NASA for projects *Gemini* and *Apollo* had received their training in the military. They pointed out that the total training needed by an astronaut "takes so long that few men are lucky enough to complete it while young enough for an assignment to a space program." Another argument they advanced for drawing both civilian and military astronauts from a single military pool is that the military can easily find work for trained astronauts not assigned to a program which will maintain their skills at a high level.

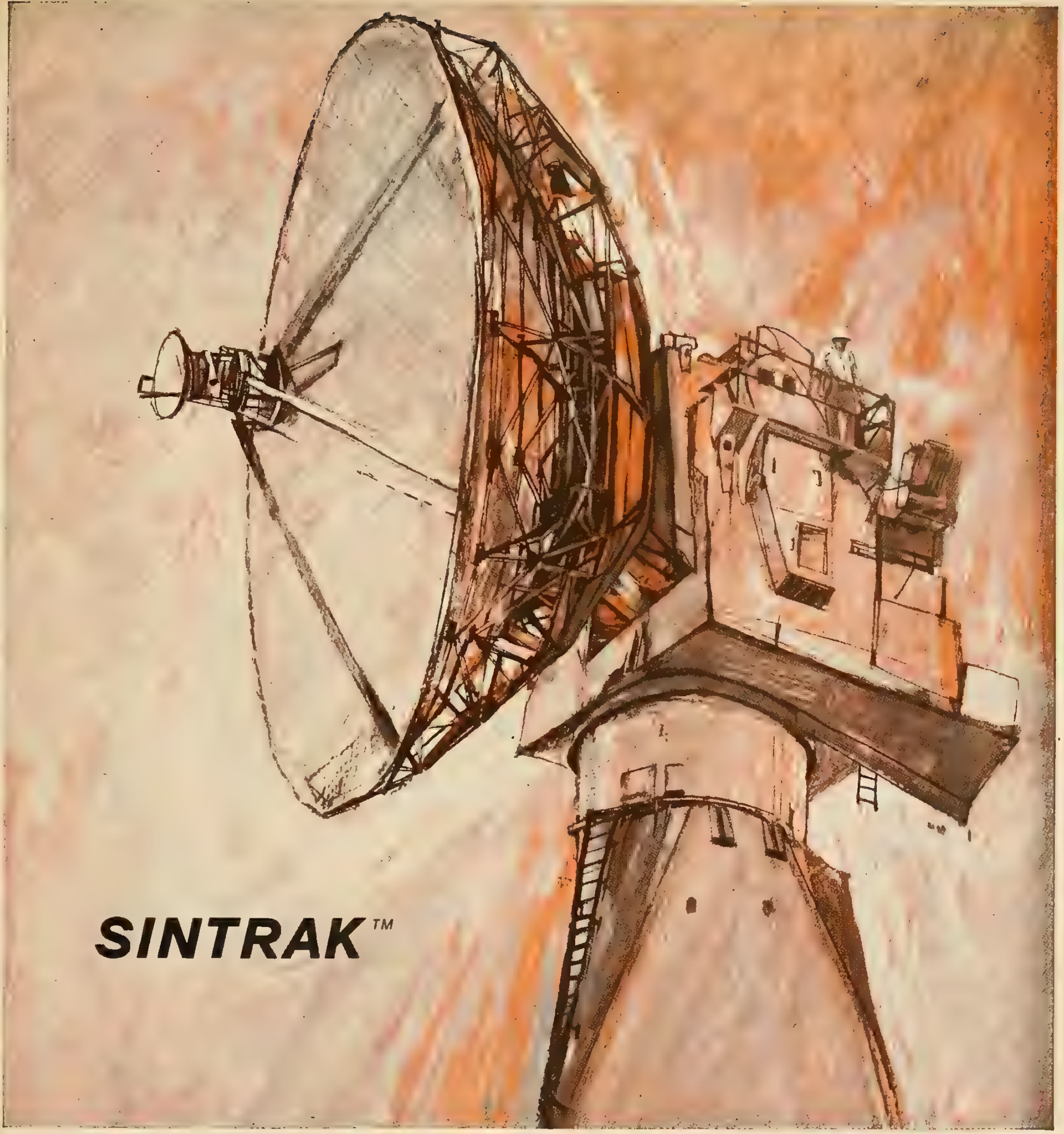
Chemical Engineers See Dearth of 'Spinoff'

HOUSTON—Chemical engineers have sharply criticized some aspects of the missile/space industry—with particular emphasis on its alleged failure to benefit the nation's civilian economy.

The barbs were delivered at the 56th convention of the American Institute of Chemical Engineers.

"Congress and industry are asking, and rightly so, 'what have been the contributions to our nation and its economy from the billions of dollars poured into support of R&D over the past 15 years?'," said Dr. W. R. Marshall, Jr., retiring president.

"For the billions of dollars poured into R&D for these programs, the resulting contribution to our civilian technology has been slight indeed, in spite of the desperate efforts by these agencies to show 'fallout,' 'spinoff,' 'spillover,' etc., to our economy."



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Impact of Possible DOD Cut Studied

Commission may be created to consider economic conversion for defense industry, automation and application of technology

by Heather M. David

CONGRESS IS EXPECTED to set up appropriate machinery to help the defense industry deal with the economic impact of a possibly lower defense budget.

Administration spokesmen—including Dr. Jerome B. Wiesner, Presidential science adviser; Archibald S. Alexander, assistant chief of the Arms Control and Disarmament Agency (ACDA); and Roswell Gilpatric, Deputy Secretary of Defense—told the Senate Subcommittee on Employment and Manpower in current hearings that the government must take steps to help the large contractors who are almost totally committed to the defense business to adjust to the possibility of losing this business.

The electronics industry will be the first to get a governmental scrutiny on what the declining defense demand might mean to it. Alexander said ACDA will commission a study this year. Other studies planned will involve the effect of regional transfers of government money.

- **Congress to act**—Several bills now being considered before the subcommittee would set up commissions on automation and on the applicability of new technology to community and manpower needs. Another bill before the Senate Commerce Committee will call specifically for a commission on economic conversion for the defense industry. Sen. Joseph S. Clark (D-Pa.) says a single bill providing for a commission combining all three functions probably will result.

- **Reduced spending**—A recurrent theme of witnesses, including Gilpatric, was that defense spending is on the decrease, even if total disarmament is not achieved. Even without new economies urged by President Johnson, one economic expert pointed out that "when one realizes that a big chunk of current spending goes for emplacement of . . . *Titans, Minutemen* and *Polaris*, it becomes clearer that defense expenditures should decline when these programs are completed." And the goal of total disarmament was reaffirmed by Senators of both parties.

However, economic expert Mrs. Betty Goetz Lall told the committee: "I suspect that one of the reasons why the U.S. Government does not press this disarmament measure as strongly as it might is that it does not feel confident it understands the full economic impact."

Wiesner told the committee he believed that it was "incumbent on the Federal Government to facilitate and stimulate private initiatives in research, development, innovation and use of new ideas to increase productivity." Other witnesses concurred that industry will not be able to do the job of converting alone.

- **Alternatives?**—Wiesner suggested a number of areas in which public needs are not being met even though the technology may be available. "The real problem seems to be institutional—rooted in our traditions regarding the respective roles of government and of the private sector, in our financing methods, and in our local and metropolitan government structures." He said that the government must increasingly find ways to do things which cannot be done by the private market economy—"like certain types of world-wide communications systems, or improved health care and community facilities."

Public transportation, the building of roads, schools and hospitals, utilization of water resources, urban renewal, and measures to combat air pollution were mentioned as possibilities to which the defense industry might turn.

The government must face up to the problem of regional shifts in defense business, Wiesner said. Gilpatric told the committee earlier that the Defense Department was making some efforts of its own to help communities prepare in advance for shifts in business.

The Presidential science adviser once again berated Congress for the heavy cuts made in the National Science Foundation budget for graduate education work. "The areas of good education and industrial development are closely-related," he said, "and this money would have accelerated development of engineering and science work in schools which needed it."

Senators on the committee indicated that they did not favor governmental control of the economy, but felt that some sort of help must be supplied the defense industry. ■

Johnson Asks Contractors to be Frugal

PRESIDENT JOHNSON has written 7,500 defense contractors to urge them to cooperate in his pledged campaign for frugality in Government.

"It is my desire," the President wrote, "that you establish an affirmative program of cost reduction in the performance of defense contracts, both those which you now hold and those which you may subsequently receive.

"If you already have such a program in being, then I call on you to accelerate, expand and intensify this effort."

Enclosed with Johnson's letters were letters from Defense Secretary Robert S. McNamara requesting that contractors follow these general rules: 1) reduce operating costs; 2) buy only what is needed; and 3) buy at the lowest reasonable prices.

The President said he and McNamara had set a target of $1.5 billion in "actually realized savings" in defense spending in Fiscal Year 1964. He noted that he had asked the Secretary to "give consideration to contractor cost savings in awarding future contracts and in fixing target profit rates."

Using TAD Booster . . .

Stationary Syncom Launch Planned

NASA NEXT YEAR will attempt to place the first U.S. satellite in a truly stationary orbit.

The flight with a *Syncom* communications satellite boosted by a *Thrust-Augmented Delta* (*TAD*) launch vehicle will be made in the second quarter of 1964.

Previous *Syncom* launches by the *Delta* vehicle were inclined to the equator because the *Delta* did not have enough energy for the more powerful thrust necessary for stationary orbiting.

In next year's flight, the spacecraft will be boosted into a looping 22,300-mi. eccentric orbit from Cape Kennedy, Fla.

At apogee, about 22,000 mi. above Sumatra, the kick motor in the spacecraft will fire, placing the satellite in circular orbit. The equatorial orbit will be achieved by a change of the orbital plane—once as the third stage fires and again as the kick motor fires at the equatorial injection point.

Syncom will then move to its on-station position at 180 degrees longitude over the Pacific Ocean. There it will be stopped by gas jets aboard the spacecraft, which will then be ready for communications between the U.S. and Asia.

Surface terminals, during the launch phase, will include a transportable station in the Pacific and the USNS Kingsport at Guam. Surface stations are under the direct supervision of the U.S. Army Satellite Communications Agency, Ft. Monmouth, N.J., which is assisting NASA in Project *Syncom*.

Ground support stations in the U.S. for the next *Syncom* launch include SATCOM Agency's Camp Roberts, Calif., station, as well as the Ft. Monmouth and Ft. Dix, N.J., installations now supporting *Syncom II*.

- **Syncom II status**—The present *Syncom II* is in a circular, synchronous orbit 22,300 mi. above the surface of the Earth and rotates at the same speed as the Earth. However, it is not in equatorial orbit, but is inclined to the equator and does not remain fixed over one point on Earth. Instead, it moves 33 degrees north and south of the equator in a figure-8 pattern.

The Lakehurst, N.J., station was recently used to halt *Syncom II's* westward drift of 45 miles a day.

Robert J. Darcey, *Syncom* Project Manager at the Goddard Space Flight Center, said the lateral drift of the satellite was about 1/10 of a degree, or about 45 mi. a day in space, and was attributed to the Earth's oblateness, which produced irregular gravitational forces affecting the satellite's motion.

He said the maneuver was executed Nov. 27, when signals beamed from the Lakehurst Station activated the hydrogen peroxide gas system aboard the satellite, 22,300 mi. in space above Brazil.

During the braking operation, which took 31½ seconds, 65 puffs of gas, each of 60 milliseconds duration, were automatically jetted from a valve on the spacecraft by ground controllers to bring the satellite to a standstill at 59 degrees west longitude, Darcey said.

Darcey said the movement of the satellite in no way affected its transmission or reception capability, and it was allowed to drift for the three-month period while NASA scientists recorded its wandering excursion.

Syncom II, originally parked at 55 degrees west longitude after its launching from Cape Kennedy last July 26, stopped on Aug. 18; due to the Earth's nonuniform gravitational field, however, it gradually accumulated a westward drift, Darcey said.

During the braking maneuver, about 5% of the total hydrogen peroxide gas supply aboard the spacecraft was used. Enough fuel remains to continue station-keeping control for several years. ■

Douglas Wins MORL Follow-on Study

DOUGLAS AIRCRAFT Co., Inc., has been selected for a follow-on study contract for refinement and evaluation of a NASA manned orbital laboratory concept.

Douglas and The Boeing Co. were selected in June, 1963, for three-month study contracts of *MORL*. Based upon performance during this period, NASA said Douglas was selected for the additional effort.

The six-to-nine-month contract is expected to exceed $1 million in value. Langley Research Center will monitor the work under the direction of NASA's Office of Manned Space Flight.

The Douglas study will consist of refining the NASA concept of an orbiting laboratory, which assumes a cylindrical six-man spacecraft capable of being launched by the *Saturn* rocket. The study will examine the feasibility of using equipment to provide intermittent artificial gravity for the spacecraft crew. Douglas also will examine the possibility of launching both ferry and supply spacecraft on a single vehicle.

- **NAA extension**—Space and Information Systems Div. of North American Aviation, Inc., also recently received an extension of a study on modifications to the *Apollo* spacecraft that may permit it to be used as a space sciences laboratory.

North American will investigate and define concepts evolving from its initial studies, suggesting link-up of modified *Apollo* vehicles.

The amendment also calls for concepts to establish the maximum number of modules that can be used, and for design for either the zero-gravity environment or artificial gravity while the stations are in space.

It also will study whether identical power and environmental systems should be placed on each *Apollo* module or if one large system could supply all modules.

North American's initial study determined man's requirements for protracted space missions and evaluated his physiological capacity to work in space under zero gravity or in an "artificial g" environment. That phase called for an investigation of possible use of the Command Module as crew quarters and an investigation of the area occupied by the Lunar Excursion Module as a laboratory.

LOOK AT LOCKHEED... IN HUNTSVILLE

Introducing Lockheed's new Research & Engineering Cente

In January, 1963 a dynamic new dimension was added to Lockheed Missiles & Space Company in Huntsville, Alabama.

LMSC's now well-established Research & Engineering Center was created to lend close support to the George C. Marshall Space Flight Center, founded by NASA to furnish vehicles for space programs; and the Army Missile Command, home of the Army's missile programs.

The Huntsville Research & Engineering Center, adjacent to the University of Alabama's new Research Center, is largely self-sufficient, capable of carrying out a wide variety of programs. Its capabilities include: Advanced engineering; analytical studies; hardware design, development, manufacturing, testing and evaluation. Specific studies, such as analyzing guidance systems, trajectory computation, optimization of payload and accuracy, post-flight analysis, and thrust vector control through secondary injection, are already being accomplished.

Living in the Huntsville area is delightful. The city, a metropolis of 120,000, is modern and bustling—the fastest growing city in the Southeast. Nearby lakes and rivers provide excellent fishing and water sports. Its scenic countryside offers a wide variety of game to the hunter. New housing is plentiful. Schools have kept pace with the rapid population growth, as have the churches and civic organizations.

In all, you will enjoy living in Huntsville. And you'll appreciate the rare challenge of growing with a new, ambitious organization.

LOOK AT LOCKHEED...AS A CAREE
Consider Lockheed's leadership in spac technology. Evaluate its accomplishment —such as the Polaris missile and th Agena vehicle's superb performanc records. Examine its outstanding advar tages—location, advancement policie creative climate, and opportunity.

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SCIENTISTS & ENGINEERS: Curre positions available in Huntsville incluc work in the following areas: Guidan analysis • Electronics • Stability & co trol • Astrodynamics • Dynamics pe formance evaluation • Aerodynamics Gas dynamics • Control systems anal sis • Thermodynamics • Structur dynamics • Computer programming Propulsion • Flight Mechanics • Op mization techniques in mathematic

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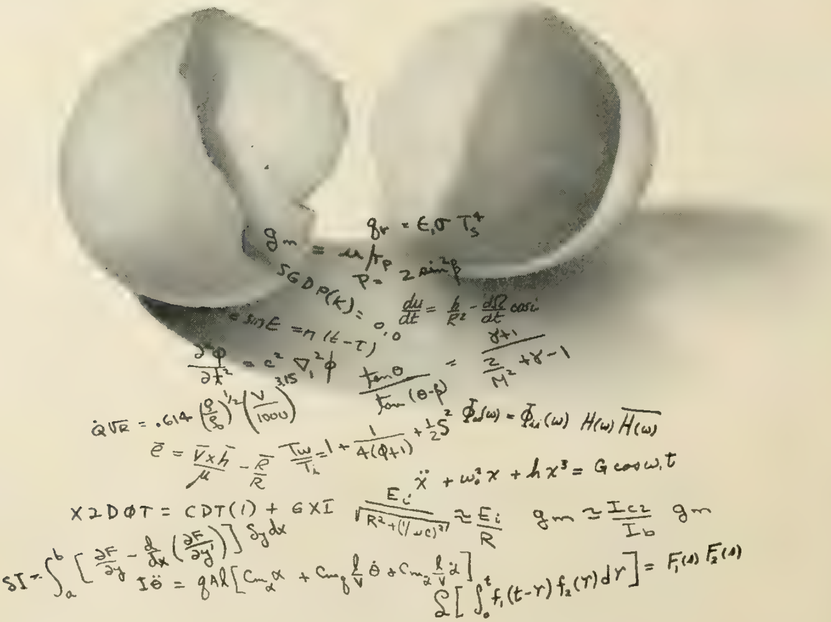
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$q_m = m/r_p$
$P = 2\sin^2\beta$
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$I\ddot{\theta} = qA\ell\left[C_{m_\alpha}\alpha + C_{m_q}\frac{\ell}{V}\dot{\theta} + C_{m_{\dot\alpha}}\frac{\ell}{V}\dot{\alpha}\right]$
$\mathcal{L}\left[\int_0^t f_1(t-\tau) f_2(\tau)\,d\tau\right] = F_1(s)\,F_2(s)$

Technical Countdown

ELECTRONICS

Dynamic Balancing by Laser

Dynamic balancing of rotational devices has been singled out by R. D. Engquist of Hughes Aircraft Co. as an important application for laser machining. Reporting experiments carried out by Hughes and the Elgin Watch Co., Engquist says the laser could adjust a balance wheel while it is on a dynamic tester. Possibly the balancing—by vaporizing a small area of metal—might be carried out while the wheel is rotating. The process could be extended to gyroscope rotors and high-speed memory rotors. The laser could balance the wheel on the tester because no tool pressure would be involved and no noticeable waste, such as chips or dust, is generated.

MATERIALS

260-in. Glass Winding Machine To Be Built

A glass filament winding complex for the construction of a 260-in.-diameter solid rocket motor case will be fabricated by the Rucker Co. under a $300,000 contract from Aerojet-General Corp.'s Structural Materials Div. Aerojet will wind two of the huge cases under an Air Force Aeronautical Systems Command Contract, and construction will commence next May. The winding operation will take place at Todd Shipyards, San Pedro, Calif., where Rucker is installing the tooling. The assembly will run nearly 20-ft. high, 40-ft. wide, and some 80 ft. in length. The mandrel and related parts will weigh in excess of 100 tons.

PROPULSION

Simple Solid Rocket Shutdown Perfected

A simple, highly effective technique for shutting down solid rocket motors without destroying the propulsion unit is under active investigation at Aerojet-General's Solid Rocket Plant. The proprietary method has been successfully used in static firing tests and does not involve blow-out ports. The procedure may pave the way to operational use of solids in manned launches.

Lunar Landing Gear Studies Continued

Bendix Products Aerospace Div. will extend and refine present knowledge of shock absorbant materials to be used in lunar landings. The $99,973 contract from NASA's Manned Spacecraft Center will cover work in additional testing of various shapes and sizes of aluminum honeycomb capsules (M/R, March 11, p. 26). Bendix also plans to build a new testing machine to study the materials under vacuum conditions in thermal environments ranging from −260° to 300° F.

ARC Vacuum Propulsion Facility Operational

A high-altitude facility capable of maintaining 0.16-mm-Hg pressure during the complete firing of small rockets with up to 20 lbs. thrust is in operation at Atlantic Research Corp. The 6 x 25-ft. chamber is pulled down through a five-stage steam evacuator with a capacity of 10,000 lbs. of steam per hour. The stainless steel chamber has 24 viewing ports and can reach a pressure as low as 0.02 mm Hg without flow conditions. ARC spent $200,000 on the facility and expects to study exhaust phenomena at altitudes including ionization and nascent oxygen recombination. Instrumentation includes closed circuit TV, transient pressure indicators and various microwave and spectrum analyzers.

College Lab Rocket Engine Developed

A continuous-burning gaseous rocket engine designed specifically for engineering school and university labs is now available from P. A. Hilton Ltd., Southampton Airport, England. All controls are manual, and electrical equipment is confined to a high-energy ignition system and a motorized fuel pump. The stainless steel motor is mounted on flexible couplings, and an even flame pattern is assured through use of a diffuser nozzle in the center of an annular oxygen stream. The combustion chamber is water-cooled. Welding oxygen and any common hydrocarbon fuel can be used.

X-15 May Be Fluorinated

There is a possibility the oxidizer combination of LOX and liquid fluorine may find its way into the X-15 program. Some engine modifications would have to be made to handle the mixture but advocates claim the performance increase is well worth the investment.

GROUND SUPPORT

Goodyear To Provide Atlas-Centaur Transporter

A huge transporter for the *Atlas-Centaur* launch vehicle is under construction at Goodyear Aerospace Corp.'s Arizona Div. The 74-ft.-long vehicle is designed for both over-the-road and aircraft hauling. Two tillermen will ride in enclosed cabs directly in front of each steerable rear wheel assembly for road movement. Both will be in constant communication with each other and the forward driver. The 11-ft.-wide transporter is equipped with special air springs and can maintain an average speed of 45 mph.

Silo Personnel Hoist Under Development

A unique electric power-hoist unit to facilitate in-silo maintenance and inspection of *Minutemen* missiles is being developed by Western Gear Corp.'s Systems Management Div., Lynwood, Calif., under a Boeing Co. contract exceeding half a million dollars. The device will permit engineers and maintenance men to descend into the silo by cable and, by means of controls held by the occupant on a small work stand, completely circle the missile at any height to check inspection stations or do any necessary service work. The unit, an adaptation of another Western Gear power-hoist widely used in building construction and maintenance work, will be installed "within the near future" in all operational *Minuteman* silos.

OPTICS

Ultra-fine Surface Measurements Made

Surface roughness in inaccessible but critical places in J-2, H-1 and F-1 *Saturn* rocket motor systems are being measured to extremely fine tolerances by Rocketdyne Div. of North American Aviation, Inc., using a Carl Zeiss interference microscope. By using light interference fringes viewed at magnifications from 80 to 480 times, surface variations have been measured to within 10^{-6} in., according to a Zeiss spokesman.

Scorpio Engine Heads Jobs At Rocket Propulsion Laboratory

Growing facility currently contracting some $45 million a year to industry; mission is to stimulate industrial propellant research

by Willard E. Wilks

EDWARDS AFB, CALIF.—A Project Scorpio 200,000-lb.-thrust research engine consisting of eight thrust chambers clustered around a common nozzle is scheduled for test-firing by the Air Force Rocket Propulsion Laboratory here late this month.

The test will initiate the third and final phase of the cellular combustion chamber program, primary objective of which is to show that highly simplified thrust-chamber assemblies can be clustered, with minimum design and fabrication effort, to provide an extremely high-thrust liquid rocket that is free of combustion instability.

Around the middle of next year, a "cap gun" tape motor, containing dozens of miniature solid motors affixed on tape, is scheduled for flight testing. A small research version of the motor weighs 1.5 lbs. and contains 1,000 impulses of 1 lb. of thrust each.

RPL also is working on a unique cambering four-ring gimbal system, a solid stacked-wafer pulse motor, large-thrust-per-element injectors, a double-grain solid motor, and application of lasers to chemical synthesis in propellant research—to list only a few of the efforts under way at or supervised by the laboratory, which spends about $50 million a year, 90% of it with industry, currently in 160 contracts.

● **Origination**—Mission of the laboratory, which in 10 years has grown from two original test stands to a complex of more than 30 major facilities worth $100 million, is to stimulate industry research in all areas of propulsion. Supporting this effort through various in-house programs, the lab conducts propellant research, develops aerospace ground equipment, performs evaluation and reliability testing, establishes propellant-procurement specifications, supports contractor development testing, and engages in advanced planning with other government agencies. RPL's total work force of 784 includes 226 engineers and scientists.

"We try to originate things here," Col. Joseph M. Silk, director, told MISSILES AND ROCKETS. "In part this is an iteration process between Air Force and industry, Air Force divisions and other agencies, a circle of which we are the hub." Final decision on what programs are to be conducted is prepared at RPL. It is carried to higher echelons for approval, but with almost negligible exceptions, such plans are approved.

RPL is one of seven AF Research & Technology Division labs.

Recent programs have produced advanced space-propulsion systems, advanced high-energy storable propellants, gelled propellants, large segmented solid rockets, advanced injector and nozzle concepts, combustion stability data and advanced rocket research facilities.

In one of its most important current efforts, RPL is monitoring and providing technical direction for contractors in Space Systems Division's Program 623A, encompassing the big solid 156-in. and 260-in. projects. With Air Force looking at the large solid specifically as a booster for nuclear engines, major emphasis is on 260-in. development.

RPL considers its end product to be advanced development programs (ADP). It currently has two such programs and is awaiting approval of three more that would result in major contracts.

Beginning with exploratory development, including both in-house and industry work, the laboratory's objective is to carry through to ADP stage. At that point, one RPL division head said, "if we have been able to market this to the weapon system people, the program goes out to industry." The lab then must increase its level of management effort. The exploratory development to ADP cycle normally runs 2-3 years.

● **In the works**—The two propulsion systems currently in ADP phase, both solids, include:

—A reinforced grain motor concept aimed at providing higher performance in upper-stage solid motors. Rocketdyne recently received the award on this following basic and applied research.

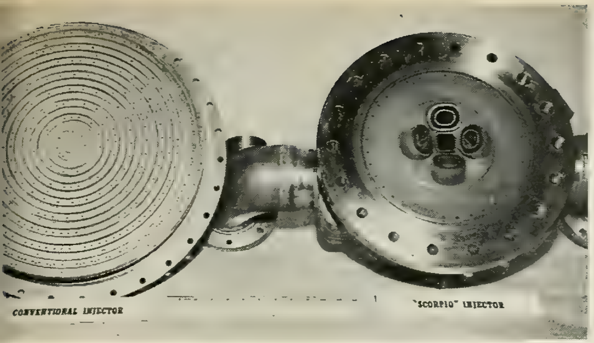
—An upper stage motor with a light metal additive to produce very high performance.

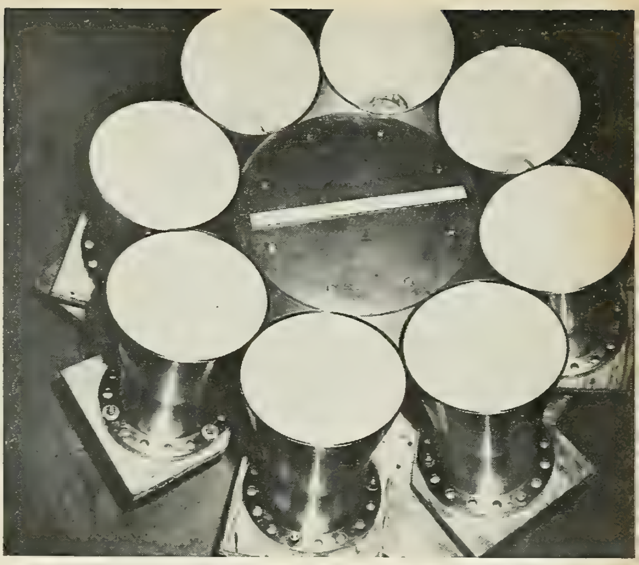
The three systems, all liquid, for which ADP funds are being sought, include:

—An advanced storable booster engine. This would integrate several advanced concepts and be similar to the Scorpio engine, incorporating chambers clustered around a common nozzle and simplified high thrust injectors.

Ideally, the chambers would operate off a single turbopump. Two-stage combustion is utilized to recover the power losses generally associated with the gas generator type of cycle. First stage of combustion occurs in an oxidizer-rich primary chamber operating under very high pressure. Resulting gases drive the turbopump turbine located between the two chambers and then are injected into the secondary combustor where the remaining fuel is mixed, combustion completed and gases exhausted into a unique altitude-compensating but non-expandable nozzle.

—A higher-energy, storable system similar in basic philosophy, but utiliz-





OVE: Single-element pentad injector (right) for Project Scor- engine compared with conventional, multi-element liquid tor. RIGHT: Nozzle arrangement for Scorpio engine is wn. Each of the eight chambers will develop 25,000 lbs. of st. The 200,000-lb.-thrust engine is slated for test firing late month or in early January.

ing advanced concepts, new advanced propellants, and tailored for upper stage work. An expandable nozzle probably would be used.

—A maneuvering propulsion system with throttling, long-term storability and multiple restart capabilities. In line with the desire to achieve multiple functions in various subsystems, attitude control would be incorporated in the basic propulsion system, with small rocket chambers utilizing the same propellant gas.

RPL is organized into four divisions, including liquid systems, solid systems, propellant, and technical support.

- **Liquid systems**—This division spends about $10 to 13 million for R&D annually, 85 to 90% of it with industry. Largest out-of-house expenditures are in three areas—space propulsion technology, large engine technology and component and propellant investigation.

Aerojet-General holds the largest contract, a two-year, $3 to 4 million R&D program for component integration for a large advanced storable engine. This involves a breadboard-type research engine demonstration. Biggest in-house liquid program is the Scorpio cellular combustion chamber project, under which investigations of unique injector designs and cooling techniques with liquid oxygen-liquid hydrogen are in process through Phases A and B.

Objectives are to demonstrate feasibility of using high-thrust injector elements and film and/or vortex cooling methods for simplifying injector-chamber design and fabrication. Final Phase C began late last month climaxing nearly three years of effort.

One of the film-cooled thrust chambers has been proven in a test firing. The chambers utilize partially expanded 15-degree conical exit sections, and impinging exhaust gases form their own aerodynamic plug, creating a zero-length plug nozzle.

A major goal of Scorpio is to establish the upper limit of the single-element injector, which RPL believes should replace the hundreds of elements in injectors now in use. Currently, the program is aimed at proving a 200,000-lb.-thrust single-element injector. Each chamber in the eight-celled engine to be fired utilizes a single-element pentad injector.

The research engine is considered only a representative scale, not an engine that would be put to use. It will be used to study the gas dynamics of clustered chambers, feed-system interactions, and what happens when one or more cells are pulsed to simulate malfunction.

In the 100 firings remaining in the Scorpio program, as much investigation as possible will be done with the big engine—including advanced injectors, cooling, use of one pump and one set of propellant valves for the eight chambers, and use of a single pyrotechnic igniter for several chambers.

- **New gimballing**—Later firings will test a unique gimballing system designed by Rocketdyne. The device consists of four wedge-shaped rings of about the same diameter as the vehicle. Top ring is attached to the airframe of the vehicle, and the bottom to the engine. The two center rings rotate to provide vector displacement. Advantage over conventional single point gimbals is reduction in length and better packaging. Pumps and other accessories can be located in the space inside the rings.

RPL believes the program will reduce liquid rocket component costs, increase reliability through component simplicity, achieve greater thrust level selectivity through use of the cellular concept, and enhance throttling and thrust vector control through use of direct area control of injector elements.

The program already has demonstrated, as a secondary objective, the feasibility of greatly reducing facility cost and development time by test-firing large liquid rockets in the inverted position. The technique has been used in testing a single-chamber 200,000-lb.-thrust engine.

The wide-ranging program also has investigated various mixture ratios of liquid oxygen and liquid nitrogen to simulate liquid air. Mixtures have been combusted together with liquid hydrogen in test runs to determine ignition characteristics and performance of a propellant combination that may be utilized in future air-scooping vehicles.

Some affirmative results have been obtained; ignition has been achieved and performance is reasonably free from combustion instability, according to Maj. J. A. Saavedra, chief of the division's engine development branch.

Design and fabrication of Scorpio chambers and injectors has been accomplished at the laboratory following initial development of the large thrust per element injectors at Aerojet-General.

In-house liquid rocket projects include, in addition, investigations into high-energy storables, ultra-low-chamber-pressure engines, novel pumping concepts, monopropellants, thixotropic propellant feasibility, nozzles and TVC

THE FLEXIBLE MEN AND THE APOLLO In today's fast-moving aerospace industry, the constant interrelating of many scientific disciplines has led to a new age of versatility.

The single-minded specialist of yesterday has broadened his horizons to meet new challenges. He has become, in effect, a modern Renaissance man. A man well-versed in all fields of knowledge relating to his world of aerospace.

Thus today's chemist is also an electronics expert. Today's mathematician is at home in space flight technology. Today's design engineer can talk propulsion with rocket men, life sciences with biophysicists.

From the resulting intellectual ferment—the intermingling of ideas—are coming achievements such as the world has never seen. Among them: the three-man Apollo module—an aerospace project being built by NAA's Space & Information Systems Division to carry America's astronauts to the moon and return them to earth. Such advances are possible only because the men seeking them are not die-cast, their talents not hardened in a single mold. For these are the flexible men.

North American Aviation is at work in the fields of the future through these divisions: Science Center, Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

evaluation, an experimental pressure feed engine, an experimental pump-feed-engine, and effects of radiation in the space environment.

A cross-section of contracts in the division includes a high-energy storable propellant engine demonstration, an ultra-low-pressure throttlable and pulsing motor, advanced nozzle concepts, tripropellant performance investigation, and single-stage-to-orbit studies.

- **Solid systems**—Propellants research takes more than a third of this division's $6 to $7-million annual budget, says Lt. Col. L. G. Patillo, division chief. Ten percent is budgeted for design, about 15% for improvement of mass fraction, 30% for nozzles and TVC work, and some 10% for miscellaneous effort, including igniters, grain design and analytical studies.

"We have started a rather concentrated effort through several programs to achieve controllability in solids for rendezvous—throttling, stop-start, by whatever technique appears most promising," Patillo reports. "We've been engaged for about a year and results show sufficient promise to encourage another year of work."

Approaches include the tape motor, the double chamber motor and the stacked-wafer pulse motor.

Seen as an attitude correction device, the tape motor, on which Curtiss-Wright has a contract, utilizes state-of-the-art propellants. The first research model was scaled down as much as possible. The individual motors on the tape are about the size of small peas. Each complete with a tiny nozzle, the motors are cast in plastic and affixed to a tape that is stored in a magazine. A stepping motor brings each into firing position. Researchers are looking for a tape material that remains flexible in the space environment.

It is estimated that the motor could be scaled up about 25 times, beyond which another system would be desirable. A problem with the small research motor has been obtaining a homogenous propellant containing consistent amounts of fuel and oxidizer in such small grains as to achieve consistent pulse reproducibility.

The 2,500-lb.-thrust, double-chamber research motor, on which work has been under way about two years, consists of two grains separated by a duct with a controllable valve. The primary chamber contains a fuel-rich grain which has sufficient oxygen to permit it to burn, but not enough for very efficient combustion. Combustion is completed when gases flow through the duct and pass over an oxidizer-rich grain. Throttling is achieved by varying chamber pressure with the valve.

Several of these motors have been fired and successfully extinguished and re-ignited, with throttling achieved over a 5-1 ratio. The concept uses conventional propellants.

There has been a fairly high degree of success in proving feasibility of the concept, which could be applied to a maneuverable satellite.

The wafer motor, on which Atlantic Research Corp. holds a $300,000 contract, is another approach to stop-start for rendezvous purposes. Several research motors of up to 5,000 lbs. of thrust, utilizing three to five pulses (wafers), have been built and fired.

Wafers consist of slices of propellant, each with its own pyrotechnic igniter, separated by insulation. A question under investigation is whether wafers can be insulated with enough lightweight material to prevent inadvertent ignitions.

Experimenters have been firing configurations with 1 to 2-sec. wafer durations.

The pulse motor could have application as a device for imparting large velocity increments to a maneuvering satellite. "We're trying to find out the problems involved, firing individually and sequentially," a division spokesman said. "We don't know what the firing duration should be in space—three seconds or 10. You might want to fire sequentially so that as the pressure from one begins to drop off, you fire the next. You might want to fire one and stop, or fire more and stop."

Judged as one of the most severe problems, from a technological standpoint, by Patillo is "the need to come up with nozzle materials and designs that will accommodate the higher-energy propellants we are trying to develop."

The division is looking at pyrolytic graphite and cooling schemes which encompass the injection of coolants such as nitrogen gas. Aeronutronic Division of Philco is one of RPL's main subcontractors in the nozzle research area, and in the past year has been defining for the lab the most promising techniques for nozzles which operate under a 6,800-7,000°F environment.

Typical contracts out of this division include work on high-temperature lightweight nozzles, metallized propellant performance validation, high-mass-fraction motor designs, TVC investigations, low-thrust pulsed-attitude control, and reinforced grain motors.

- **Propellant division**—The propellant division remains interested in a 10% increase in the specific impulse of fuel and oxidizer combinations, but Lt. Col. G. F. Babits, division chief, reports that "what we really would like to see is somebody come up with an increase of one or two hundred percent.

"We're running off the end of the periodic table. The limits are pretty well defined, so that is the reason we're looking at things like high temperature and pressure. We're interested in new ways to store energy in the propellant."

The division is applying a small ruby laser to an area in which it believes the laser never has been used previously—chemical synthesis. Whether the idea has merit remains to be seen, since the effort has just started. Researchers are fascinated by the possibilities the laser offers as a high-temperature source for heating materials quickly to avoid changes that occur in a slower heating process. It also appears to offer the same advantage in reverse—quick cooling following laser application because of the small area involved should enable "freezing out" of substances that otherwise are lost in slow cooling.

The division is also utilizing shock tubes for synthesis investigations in both liquid and solid propellants.

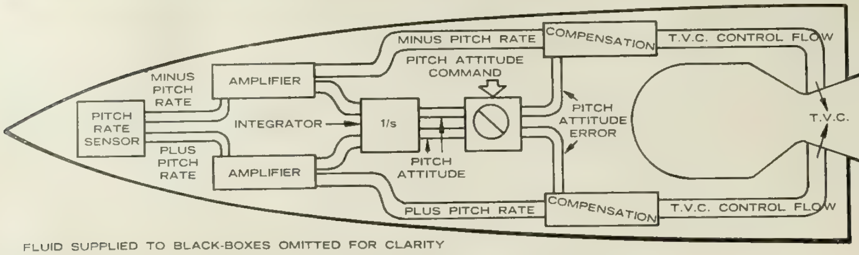
In its liquid propellant work, the division is mainly interested in development of higher energy storables to meet the military mission. Effort includes research into gelled propellants, higher-energy oxidizers containing fluorine and oxygen, and seeking ways to make them storable, perhaps by adding other elements.

The division has four sections, including a liquid propellants branch, a solid branch, a test and evaluation branch, and a chemical and materials branch. They split a budget of about $10 million a year, about half of it from the Defense Dept.'s Advanced Research Projects Agency for managing that portion of the agency's propellant program that is supervised by the Air Force. About $4.5 million of the funds go into contracts that include extensive programs with major chemical companies. Most of the current 45 contracts are for synthesis work. Contracts include work on metal hydride-containing fuels, Hybaline characteristics, high-energy monopropellants, and high-energy polymeric binders.

The division has several in-house programs to upgrade existing liquid systems.

Finally, the function of the lab's Advanced Plans and Analysis Office requires that it be cognizant of the needs of higher headquarters and users, such as the various Air Force divisions and operating commands. This month, the office will start planning for the exploratory development RPL will do in 1965. The office will conduct or sponsor evaluation studies on systems and concepts in support of this planning.

NASA is now adding stands for F-1 production testing at the site. The first is to be finished shortly after the beginning of the year, while United Technology Corp. will complete in February a new *Titan III* development facility. ■



FLUID SUPPLIED TO BLACK-BOXES OMITTED FOR CLARITY

SIMPLIFIED one-degree-of-freedom missile control system using pure-fluid amplifiers.

missile guidance

Pure-Fluid Guidance Advances Through Research at Giannini

Company uses double-leg elbow amplifier to thrust-vector cold-gas jet at Mach 2; concept promises systems surpassing electronics

by Rex Pay

CONTROL OF secondary-injection thrust-vectoring by a pure-fluid amplifier has brought the all-fluid guidance system for missiles a step closer to reality.

Astromechanics Research Division, Giannini Controls Corp., Malvern, Pa., has thrust-vectored a cold-gas jet operating at about Mach 2, by means of a double-leg elbow amplifier (DLEA).

This was part of a company-funded study of fluid-amplifier control of secondary injection in various expansion regions of a jet nozzle. The division has a contract from the Army to develop a fluid amplifier and a contract from the Air Force for basic research into fluid flow.

• **Potential**—Pure-fluid, or fluid-state, control systems are drawing interest because they promise reliable miniature systems that can function where electronics cannot. Because pure-fluid devices usually consist of a gas flowing through shaped channels in a refractory material, they are rugged, resistant to high temperatures, and unaffected by nuclear radiation.

They have no moving parts and are therefore faster than conventional pneumatic or hydraulic systems. They are insensitive to vibration. And their simplicity is likely to make them very cheap.

An application that looks suitable for pure-fluid systems is control of a nuclear rocket operating for long periods at high temperatures. Present electronic systems would incur a severe weight penalty due to their need for substantial shielding.

Although most systems under development use gases, some studies are being made of liquid devices. The idea is that a fluid control system might often use the same fluid as the system it controls. A missile control system would use missile exhaust gases; an underwater vehicle propelled by a water jet would use the same water in its control system.

• **Missile proposal**—An outline of a pure-fluid control system for a missile has been given by Melvin B. Zisfein, General Manager, Astromechanics Research Division.

A fluid-state sensor would detect missile pitch rates, reading them out as a modulated fluid flow. Alternatively, the output variable could be pressure. Whatever the type of sensor output, it would be at low level and would pass to a pure-fluid amplifier. Part of the output of this would be integrated to provide an attitude signal.

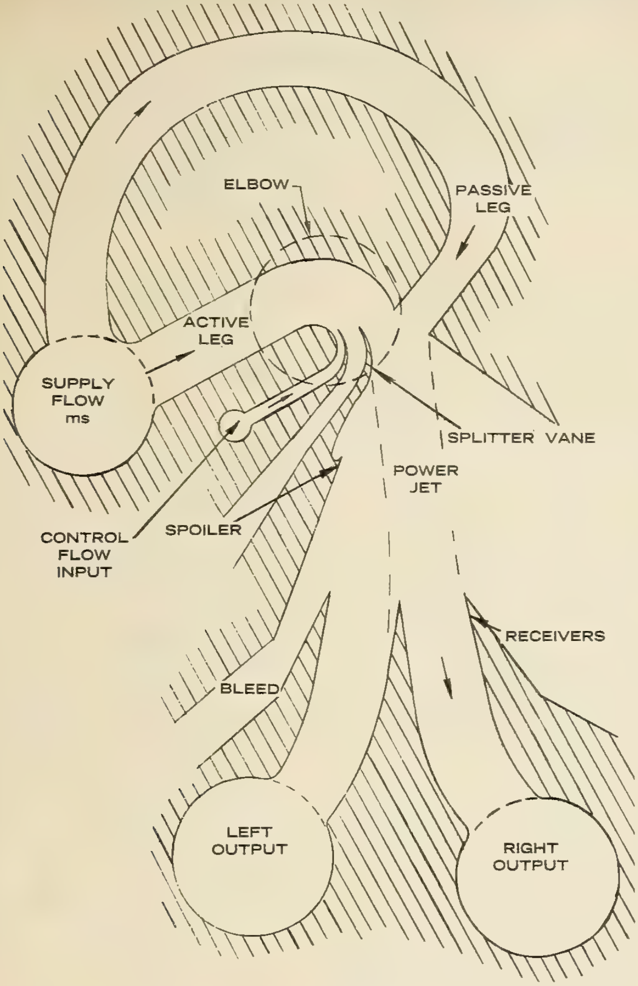
Comparison of fluid rate and attitude signals with appropriate command signals would yield error signals, that, after amplification, would actuate directly a thrust-vectoring system for missile steering.

Of the components required for missile control systems, proportional amplifiers and digital logic units probably have advanced furthest in development. Sensors—to measure such factors as pitch rate, temperature, pressure—have progressed more slowly, and most of the information published on them is classified.

The majority of contracts in this field are either for basic research into fluid flow under rather unusual conditions, or for development of new fluid-state devices to the stage where their performance can be measured.

One or two contracts have been let for simple all-fluid control systems, to demonstrate the feasibility of the technique.

• **Giannini system**—The double-leg elbow amplifier developed by Giannini uses a small control flow to alter the



GIANNINI double-leg elbow amplifier. Addition of a spoiler to smooth contour after elbow prevents bistable operation.

oint of separation of a main flow round an elbow. Altering the position f separation varies the distribution of e main flow between the output annels.

The control stream emerges from e control passage in the opposite di- ction to the main flow. The inlet flow the elbow provides about half of e total main flow, the other half ing provided by a passive channel.

With no counterflow from the con- ol stream, the active supply flow fol- ws the bend of the elbow and the ain flow goes out of one output chan- l. When full counterflow is applied, e point of attachment of the active w moves back and diverts the main w into the second output channel. tween these extremes, the main flow is divided between the two channels in proportion to the control flow volume.

In the suggested missile system, the small controlling counter flow would be provided by the pitch-rate sensor. The output of one channel of the amplifier would provide the main pitch-rate signal, while the output of the other channel could be processed suitably and integrated.

With such an amplifier, a differential mass-flow gain of 220:1 has been achieved. Fall-off of high-frequency performance in the amplifier occurs due to the transport lag down the output channels. If a detector is placed just below the point of confluence of the elbow and counterflow streams, the

Motivation

Martin Denver knows the importance of placing individuals in the **right** career opportunities. It knows the influencing factors that attract top qualified personnel...and it has built a dynamic force through the development policies and procedures that make these factors a standard company offer: challenging programs • progressive attitudes • excellent working conditions • rewarding compensation • opportunity for personal and professional success.

You will get immediate consideration for aerospace assignments in Martin's TITAN III program if you qualify in any of the following—or related—fields:

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- **ORBITAL MECHANICS**
- **CONTROL ELECTRONICS**
- **STRUCTURAL DYNAMICS**

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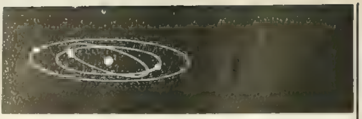

SCOPE *is the range within which an activity displays itself.* The scope of CryoVac in the field of cryogenics is practically limitless. It is the result of a careful blending of people, experience and facilities—people including some of the earliest researchers in the field of cryogenics, experience gained through development of some of the earliest space-age cryogenic projects, modern facilities geared solely to the field of cryogenics. ■ The scope of CryoVac not only includes the design and construction of cryogenic hardware and systems, systems engineering studies, but the capability to conduct research and development programs on a contract basis. This capability has not been limited to space simulation but to other projects as well. For instance, CryoVac was selected to perform an advanced study and preliminary design of the low temperature systems for the AEDC, Mark II facility. These cycles will be the largest cryogenic processes ever designed involving thousands of compressor horsepower. ■ This almost limitless scope of activity in cryogenic Research and Development is at your disposal—why not take advantage of it?

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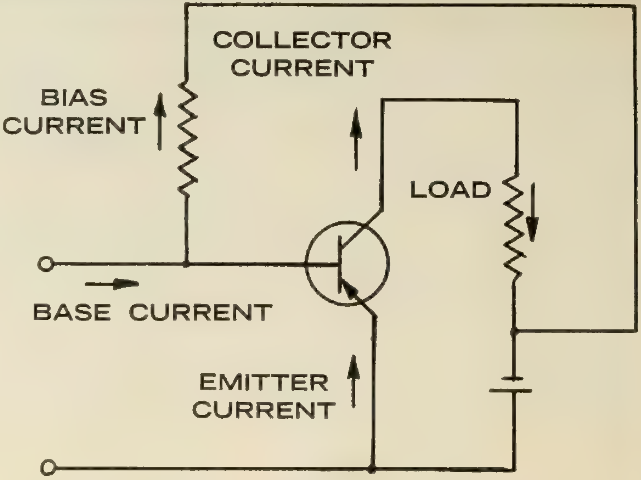


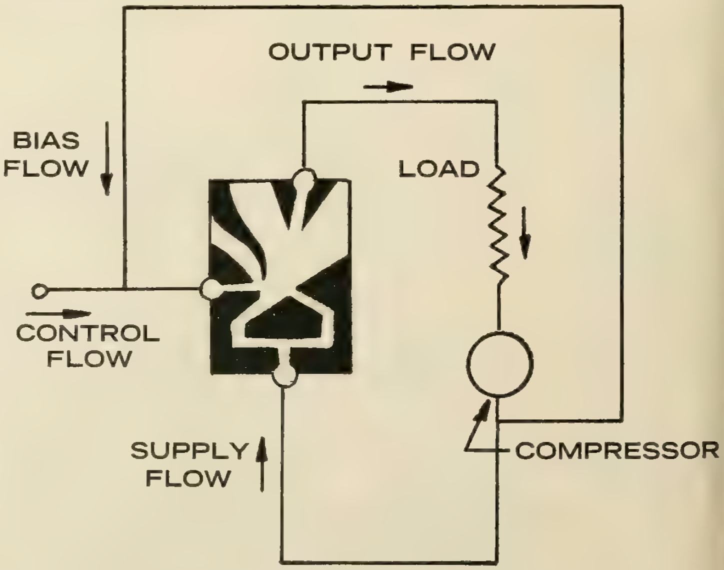
Transistor Current Amplifier

device will respond to frequencies up to about 2.0—the frequency limit of the available test equipment.

With the detector located at the output of the device, the response is flat from 0.1 cps to 1 cps, dropping by about 3 db at 10 cps.

- **Complexity**—The Giannini DLEA is analogous to a transistor, and an approximately equivalent circuit diagram can be drawn for it. Electroni circuit theory can be applied to flui state systems, except that the circu constants cannot be lumped. Instea pressure and flow relationships are cor siderably more complex.

Transistor current gains are ver often in the range of 10-100, whic compares closely with the mass-flo amplification of the DLEA. This de



Fluid-State Mass-Flow Amplifier

THE PURSUIT OF ENGINEERING EXCELLENCE

This statement of policy was presented to the membership of the McDonnell Aircraft Corporation Management Club by Vice-President of McDonnell Engineering, Mr. Kendall Perkins. If you, as an engineer, are encouraged to seek greater excellence in your work, you will gain. If you are successful in your search for excellence, the Nation will gain.

"The pursuit of engineering excellence doesn't get talked about much—perhaps because it seems so obvious. It should be talked about more, however, because too few engineers recognize its vital importance or go to enough trouble to achieve it.

"To excel means to surpass or outdo. As applied to the kinds of engineering with which our company is mostly concerned, the pursuit of excellence might be defined as the attempt to do a better engineering job than anyone else. This isn't easy. There are a great many smart and energetic people in the aerospace industry and we're competing for an amount of business which isn't enough to keep all the capable groups as busy as they would like to be. Of course, this makes excelling all the more necessary.

"To effectively outdo the competition, an individual or an organization must:

1. Be fully conscious of the need to do a better job,
2. Have the ability to do a better job,
3. Have the desire to do a better job,
4. Work under conditions which permit doing a better job, and
5. Keep up the effort without letup.

"It is rare to find all these conditions in fullest measure. But every one is necessary and the success of an organization depends on the presence of such conditions. The same may be said with respect to each individual in the organization.

"The first of these requirements is to *be fully conscious of the need to excel.* From the standpoint of the collective group—the company or the engineering divisions of the company — the need is apparent. From the standpoint of each individual engineer, you would think it would be equally obvious, but it doesn't always seem to be. Our contracts make us responsible for a major segment of progress of our Nation. They demand our finest performance. Excellence is to be expected of those given assignments indicative of great national trust.

"*The ability to excel* isn't equally given to all of us but that doesn't mean we can't do better than we do. There is such a close relation between the ability and the desire that those who are anxious enough to excel very often do. You will find that the most successful people are just as likely to have ordinary ability and an outstanding desire to excel as they are to have ordinary desire to excel and outstanding ability. Of course, there are those who have plenty of both, but they can take care of themselves.

"*The desire to excel* is like 'will to win' in a game. It's hard to measure beforehand, but the results are easy to see. It isn't nearly enough for someone in charge of a project or proposal to have the great drive to do a better job than anyone else has ever done. Our engineering jobs must now depend on the efforts of many people. Unless they have a collective 'will to win' the chance for proposal and product excellence is slight.

"By *working under conditions which permit doing a good job,* I do not mean keeping the office well lighted, or paying a high salary, although these factors are not unimportant. Creating and keeping an environment for best operation of a winning team is one of the most important responsibilities of engineering management. It calls for many things including, but certainly not limited to, these:

1. Recognition and appreciation of the special abilities and efforts of each individual,
2. Assignment of the maximum amount of the most difficult work to each individual in accordance with what that individual is capable of doing well,
3. Scrupulous insistence on fair treatment of all concerned including the customer,
4. Following policies which are consistent and understood,
5. Establishing and working toward objectives which are recognized as worthy,
6. Insisting that engineering decisions be made, insofar as practicable, on the basis of the over-all best interests of the largest appropriate group—the project, the company or the country, rather than primarily in the interest of individuals or their immediate groups,
7. Having the wisdom to avoid proposals unlikely to win, or projects unlikely to be fruitful, through no fault of the engineers who worked so hard toward their success,
8. In general, doing everything practicable to maintain a winning atmosphere.

"All this may sound unduly pious. But I really believe that promoting these conditions pays off in very practical ways.

"*Keeping up the effort* is probably the hardest condition to satisfy. As with other homely virtues, when effort is continued most consistently, it often seems appreciated least. There is no substitute, however, for the persistent expenditure of extra effort, otherwise known as 'hard work.' As in the case of almost all important creative accomplishments, notable success stems 10% from inspiration and 90% from perspiration.

"Although it seems harder each year to do the kind of engineering which excels, our competitors, and the Russians as well, have similar handicaps. We can keep ahead if we continue to exert ourselves in the pursuit of excellence. If we do this as well individually as we have in the past, I do not see how we can fail collectively to grow and prosper."

Additional engineers, scientists, physicists, and mathematicians with energy and enthusiasm are needed for projects in the National interest now underway at McDonnell. If you would like to work where the pursuit of excellence is a permanent corporate goal, the brief resume form below is included for your convenience.

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Mail This Form To: D. F. Waters, McDonnell Employment, Dept.62MM,Box 516, St. Louis, Mo., 63166

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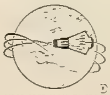
Education: BS_____ MS_____ Ph D_____ Major Field:__________

Date Date Date

Primary Experience Area:__________ Present Position:__________

__________ Number of Years_____ __________ I would like to receive application form ☐



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vice is optimized for mass-flow gain, but also has an appreciable power gain (37:1) and a pressure gain of 1.7:1. Tests were carried out at various power levels between 0.6 and 600 watts, and the amplifier's mass-flow gain remained constant across this range.

When the phase shift of the amplifier is corrected for transport lag, the remaining lag is less than would be expected, indicating that the amplifier has some non-linear dynamic characteristics. In some configurations the device can have a fall-in gain of 12 db/octave, above a critical frequency, and can be used as a low pass filter.

Appearance of a delay term due to transport lag forms one of the major differences between fluid-system transfer functions and those of electronic systems. In fluid control systems, serial combinations of elements will compound this lag and make for instability. To overcome this problem, devices will have to be made smaller and fluid velocities increased. Also there is a need for the development of pure-fluid differentiators and lead-lag networks.

- **New stimulus**—Many different types of fluid amplifier are under investigation at other companies, but a feature they frequently share with the Giannini device is that their characteristic flows are those avoided in other applications of aerodynamics. Because of this, and because these flows are difficult to analyze, the flow regimes that look good for pure-fluid devices have received relatively little attention in the past. Now there is a new stimulus for basic research into fluid flow.

Various types of digital fluid-logic units are being developed. Although they are quite slow compared with electronic systems, their smallness and low cost are expected to permit extensive use of parallel operation to make up for some of their lack of speed. In fact, parallel operation may be essential to avoid instability in control-system applications.

If fluid digital computers are produced, their future missile applications seem more likely to be in Army tactical field missiles than in intercontinental ballistic missiles, as the trend in ICBM computers is toward higher capacities and faster speeds.

An all-fluid inertial computer that forms part of a gyro platform is one speculation that illustrates the size ultimately expected for pure fluid systems. However, to approach this scale of miniaturization calls for an order of magnitude improvement or more in the manufacturing tolerances for etching shaped passageways.

Zisfein estimates that an intertial guidance computer using pure-fluid devices would require between 10,000 and 20,000 elements to provide three-figure accuracy. Many of these would be connected serially. So, to provide necessary speed and system stability, elements would have to be minute and densely packed. With the present state of fabrication art, the number of interconnections might degrade the reliability of the system well below that of a comparable electronic computer at room temperature, suggests Zisfein.

Two-figure accuracy could be provided by a pure-fluid analog computer of about 50 elements. This would not have to be so small. A large device might even be preferable, to drive actuators directly. The number of connections would be drastically reduced, and the reliability should be far better than that of an equivalent electronic device.

Its low accuracy would bar an analog computer of this type from inertial applications, but a hybrid analog-digital system might be feasible. Zisfein believes that an analog pure fluid computer would be well-suited for autopilot work. ■

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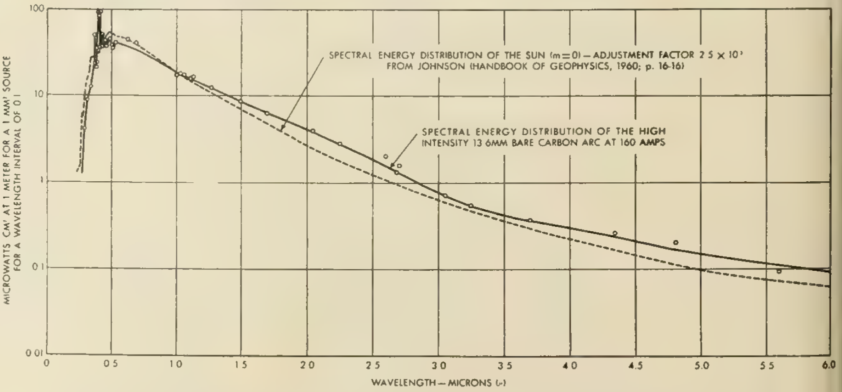

HERE'S PROOF! The above chart illustrates the excellent match of the bare 13.6mm carbon arc spectrum and the solar spectrum as encountered above the earth's atmosphere. For comprehensive data, request a copy of "Studies in the Spectral Energy Distribution of Different Light Sources in Connection With Solar Simulation," a report from our Development Laboratories.

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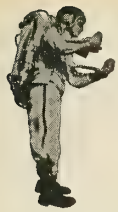

Engineering Spectaculars – Fact, not Fiction at Bell Aerosystems . . .

In the technical community, what sort of programs warrant the designation "spectacular"? Here are *five* that do, and they're typical of the many unusual engineering challenges at Bell Aerosystems. ☐ ☐ ☐ **the free-flight personal Rocket Belt,** making man's agelong dream of controlled individual flight a reality. Already successfully flight tested for the military, the Rocket Belt is being considered for a variety of new applications. ☐ ☐ ☐ **the Hydroskimmer, SKMR-1,** largest GEM ever built in the U.S., is opening up a new mode of transportation. Designed and built for BuShips, this vehicle skims 1½ feet above water at speeds of more than 70 knots, as well as over land, marsh, and other types of terrain. Navy Phase III operational test program is being conducted on Lake Erie. ☐ ☐ ☐ **LLRV-Lunar Landing Research Vehicles,** which will permit astronauts in training to physically fly a simulated lunar flight. ☐ ☐ ☐ **X-22A, Tri-Service VTOL Jet Transport,** research aircraft in which the propulsion and control elements are utilized during *all* phases of hovering, transition, and conventional flight. Two of the dual-tandem, ducted-propeller aircraft are to be built to explore these concepts for flight characteristics and military potential. ☐ ☐ ☐ **Space Guidance & Control Systems,** for advanced Orbital & Re-entry vehicles with new requirements. These include all aspects of manual and automatically controlled energy management. ☐ ☐ ☐ If you are interested in applying your vision and skill to outstanding innovations in engineering history, look into these opportunities with Bell Aerosystems:

SYSTEMS ENGINEERS For technical direction of systems aspects of advanced R&D programs, including all aspects of the dynamics, flight control, and guidance of aerospace vehicles. Prefer MS in Engineering and 7 to 10 years applicable experience. **Salary to $18,800.**

PROJECT ENGINEER–GEM VEHICLES To assume technical direction of GEM R&D programs. Must be capable of integrating analytical data from all engineering and scientific disciplines. BS AE degree and related project aircraft experience required with GEM experience most desirable. **Salary to $15,400.**

SPACE SYSTEMS DEVELOPMENT ENGINEERS To determine requirements and advanced concepts for space vehicles and space propulsion systems through company-funded and contractual advanced design studies. Assignments will include the coordination of activities in the preparation of major proposals, being cognizant of technical approach, scheduling and cost aspects. Successful proposals offer the potential of appointment to technical direction or project engineering responsibilities. BS in Engineering required with advanced degree preferred, and 8 to 15 years experience in system engineering. **Salary to $18,800.**

RAMJET AERODYNAMICIST Technical specialist to perform aero-thermodynamic analyses and plan and conduct tests of ramjet engine systems. Should have experience in complete engine test as well as component systems such as controls. MS or equivalent in AE or ME plus 7 to 10 years applicable experience required. **Salary to $15,400.**

SENIOR STRUCTURES ENGINEER To direct the activities of a small group of structures engineers in design analysis of complex structures, shells and pressure vessels. Work will be oriented toward structural analysis of liquid propellant rocket engines, turbine pumps, thrust chambers, valves and components. Engineering degree with 5 to 10 years of related experience required. **Salary to $15,400.**

PRELIMINARY DESIGN ENGINEER To conduct analytical and design studies in all areas of liquid propellant rocket engines and injector systems. To be responsible for conceptual design and supporting analysis for new rocket propulsion systems. Requires an advanced engineering degree plus 6 to 12 years related experience. **Salary to $18,800.**

Resumes are invited from Engineers qualified for positions in one of the areas listed above. Please address Mr. Thomas Fritschi, Dept. C-39.

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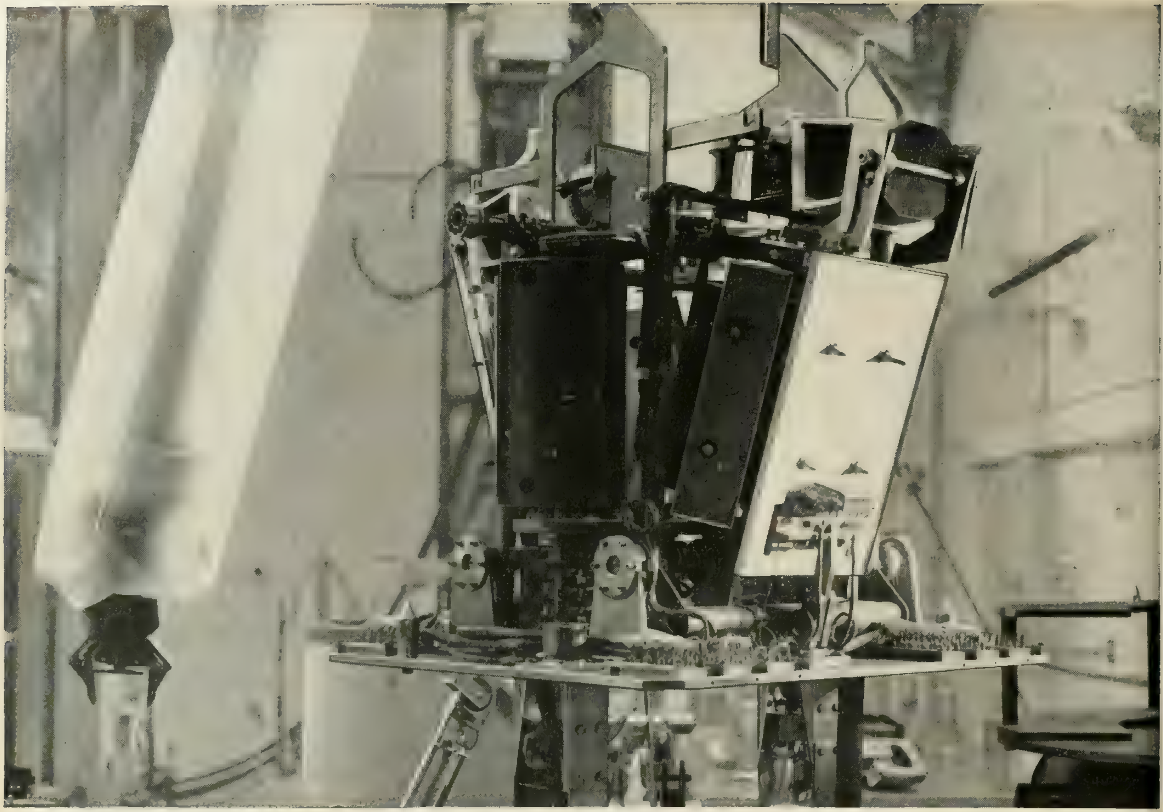

How you can help develop compact nuclear systems for space

Now, at Atomics International, you can take part in one of the most advanced nuclear projects of our time: the development of SNAP compact power systems for space. A.I., as a SNAP systems prime contractor for the Atomic Energy Commission, is responsible for the complete nuclear power system including development and integration of the reactor and shield, power conversion and space radiator subsystems. Complete flight systems are subjected to both nuclear and non-nuclear launch qualification. SNAP systems are designed to provide from 500 to several thousand watts of auxiliary power while operating unattended in space for a year. SNAP is one of many challenging nuclear projects underway at A.I.

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Contact: Mr. H. M. Newton, Personnel Office,
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Atomics International technician begins disassembly and examination of SNAP 2 Development Reactor in hot cell following completion of reactor's 21-month test operation program. AI conducts SNAP 2 program for Atomic Energy Commission.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

ATOMICS INTERNATIONAL
Division of North American Aviation

Mergers and Acquisitions

Douglas Aircraft Co., Inc., Santa Monica, Calif., is transferring the assets of its subsidiary, Astropower, Inc., Newport Beach, Calif., to divisions of the parent company, which will carry forward work on current contracts. Astropower was organized in 1960 for research and development in advanced propulsion fields. It has also carried on research in other subjects under government contract. . . . *International Telephone and Telegraph Corp. has completed acquisition of the assets of Cannon Electric Co., Los Angeles, by a new subsidiary, ITT Cannon Electric, Inc. Cannon is an international supplier of plug and receptacle assemblies for missile/space, industrial and commercial use, including miniature and subminiature plugs for missile, satellite and radar circuitry. Cannon shareholders approved the sale to ITT at a special meeting Nov. 22.*

New Firms and Divisions

Schaevitz Engineering, Pennsauken, N.J., has agreed to acquire the stock of Bytrex Corp., Newton, Mass. Brytex manufacturers solid-state pressure transducers, strain gages, torque meters, semi-conductor load cells, instruments and systems. . . . *Fidco (Filtors Incorporated Distributing Co.) has been formed in East Northport, N.Y., as an independent distributor of Filtors, Inc., standard relays.*

Continued Electronics Growth Seen

In its current newsletter, Goodbody & Co., New York brokerage firm, predicts that the electronics industry, already among the largest in the country, will continue to grow after the mid-1960's when they see other defense and space industries' growth leveling off. Contributing to the favorable outlook for the major firms in the industry, says Goodbody, are improved contracting procedures with government agencies, the opening of major new markets for advanced products now coming from the research laboratories and a general tightening of control of overhead costs.

International

Radio Corp. of America's Canadian subsidiary, RCA Victor Co., Ltd., Montreal, has received a $5-million contract to build a major ground station for satellite communications in eastern Canada. The experimental station, to be constructed for the Canadian Dept. of Transport, is scheduled to begin operational tests by the fall of 1965, coincidentally with the expected launching by the U.S. of a second-generation *Syncom* satellite, providing new intercontinental space relay facilities for voice, television, teletype, facsimile and data transmission. . . . *Leach Corp., a West Coast aerospace electronics firm, is transferring its international headquarters from Zurich to Geneva, Switzerland.*

Industry Facilities

Cannon Electric Co. (recently acquired by ITT) has expanded its Santa Ana, Calif., facilities to provide an increased manufacturing capacity and an area for new laboratory test equipment. The plant has acquired additional production space and new production machinery and equipment, constituting an additional investment of $1.75 million. Included in the expansion is a rubber research and production facility, which will enable the Santa Ana division to produce its own rubber insulators. The division now produces all its contacts, shells, and insulators for all Cannon plugs manufactured at Santa Ana. . . . *Natel Engineering Co., Inc., Van Nuys, Calif., has moved to a new 6,000-sq.-ft. production, research and administration building. NE manufactures airborne and ground support equipment signal conditioning components for instrumentation and control systems.* . . . NTH Products, Inc., El Cajon, Calif., a subsidiary of the Carpenter Steel Co., Reading, Pa., has expanded its facilities for making thin metal tubing for aircraft and missile applications. With the new facilities, NTH can produce round, shaped, tapered and laminated thin-wall tubing from virtually every weldable metal, including austenitic, martensitic, ferritic and precipitation-hardening stainless steels, corrosion- and heat-resisting grades, nickel-base and cobalt-base alloys, high-temperature alloys, reactive alloys and heat-treatable low-alloy grades. . . . *Hal Marlowe Associates, a Los Angeles consulting firm in public and governmental relations, has opened a Cape Kennedy office as a result of the firm's increased activity in the area of business development and sales consulting.* . . . The Huntsville (Ala.) Research and Engineering Center of Lockheed Missiles & Space Co. has moved into a recently completed 54,000-sq.-ft. structure at Huntsville Park, adjacent to the University of Alabama Research Institute. The one-level building is the first unit of a 750,000-sq.-ft. complex which will be realized if growth of the center continues as anticipated. Included in the move was the separate Huntsville office of the company's Nuclear Space Programs.

Company Representatives

Liquidonics, Inc., Westbury, N.Y., has appointed six distributors to handle the company's line of hydraulic piston accumulators, as well as related products. The Airoyal Co., Maplewood, N.J., will distribute throughout the New York City area. Fluid Power Products, Westwood, Mass., will cover New England; Winco Fluid Power Equipment and Machinery, Huntington Valley, Pa., will cover eastern Pennsylvania. Joseph V. Tripoli & Co., Buffalo, N.Y., will handle upper New York state; Stanley Berg, Inc., Pittsburgh, Pa., will cover western Pennsylvania and West Virginia; M & J Associates, Inc., Timonium, Md., will cover Maryland, Virginia and the District of Columbia.

AWARDS

AIR FORCE

$24,000,000—**Massachusetts Institute of Technology, Lincoln Laboratory**, Lexington, Mass., for further research and development on joint services projects in the national defense.

$6,000,000—**Ryan Aeronautical Co.**, San Diego, for delivery of 175 Q-2C *Firebee* jet target drones to both the AF and Navy.

$6,000,000—**Avco Corp.**, Wilmington, Mass., for further work on re-entry vehicles for the *Minuteman* weapon system.

$5,129,000—**North American Aviation, Inc.**, Anaheim, Calif., for continued work on *Minuteman* missiles.

$2,667,000—**United Electro Dynamics, Inc.**, Alexandria, Va., for continued work on a classified project.

$2,100,000—**Avco Corp., Lycoming Div.**, Stratford, Conn., for *Minuteman* re-entry vehicles.

$2,000,000—**General Dynamics Corp., Astronautics Div.**, San Diego, for continued work on the *Atlas* space booster.

$2,000,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for services and related equipment for an unidentified launch vehicle program.

$1,800,000—**North American Aviation, Inc., Autonetics Div.**, Anaheim, Calif., for continued production of guidance and controls systems for the *Minuteman* missile system.

$1,516,000—**North American Aviation, Inc.**, Anaheim, Calif., for repair and overhaul of *Hound Dog* air-to-ground missiles.

$1,500,000—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for continued work on an electronic subsystem of *Minuteman* missiles.

$1,400,000—**Avco Corp.**, Wilmington, Mass., for continued work on a classified program.

$1,300,000—**Analytical Services, Inc.**, Alexandria, Va., for studies of tactical and strategic air defense methods and logistics operations.

$459,000—**General Precision, Inc., Aerospace Group Systems Div.**, Little Falls, N.J., for a miniature inertial navigation system with test console needed for field calibration and laboratory checkout of the system, plus spares.

$353,100—**Douglas Missile & Space Systems Div.**, Santa Monica, Calif., for a study of the properties of extremely thin metals proposed for use in advanced re-usable orbital vehicles.

$170,408—**Avco Corp., Everett Research Labs**, Everett, Mass., for a study of the properties of collisionless plasmas.

$79,616—**Thiokol Chemical Corp., Reaction Motors Div.**, Denville, N.J., for development of solid propellant spectroscopic tracing methods.

$59,825—**Radio Corp of America, Sarnoff Research Center**, Princeton, N.J., for continued research on plasma energy relationships.

$52,000—**TRW Space Technology Laboratories**, Redondo Beach, Calif., for engineering services for the *Atlas D, E* and *F* and *Titan I* weapons systems.

$44,000—**Smithsonian Institution**, Washington, D.C., for observations of satellites *388* and *424*.

$27,855—**Varian Associates, Inc.**, Palo Alto, Calif., for an analytical nuclear magnetic resonance spectrometer.

Space-General Corp., El Monte, Calif., improved telemetry at the Atlantic Missile Range involving delivery of predetection receiver-recorder groups and associated equipment (undisclosed amount).

ARMY

$30,700,000—**Raytheon Co.**, Lexington, Mass., for *Hawk* missile guidance and control system packages.

$13,400,000—**C. H. Leavell & Co., and Peter Kiewit Sons' Co.** for construction of *Saturn* second stage test facilities at NASA's Mississippi Test Facility.

$2,358,152—**Western Electric Co.**, Burlington, N.C., for modification kits to improve the *Nike-Hercules* weapon system.

$1,093,292—**Raytheon Co.**, Lexington, Mass., for production of ground support equipment for the *Hawk* missile system.

$634,600—**Retenbach Engineering Co.**, Knoxville, Tenn., for construction of an engineering laboratory for use in connection with the aerospace environmental chamber, Mark I.

$515,975—**V. W. Pangborne & Co., Inc.**, Philadelphia, and **Lowry Electric Co., Inc.**, Coral Gables, Fla., for construction of an electrical substation for the lunar launch complex on Merritt Island, Fla.

$79,849—**Syracuse University Research Corp.**, Syracuse, N.Y., for a one-year study of radar sensors and associated devices.

$65,859—**Microwave Associates, Inc.**, Burlington, Mass., for a one-year study of high-power gaseous electronics.

NAVY

$885,000—**North American Aviation, Inc., Rocketdyne-McGregor Div.**, McGregor, Tex., for production of advanced solid propellant motors for the *Sidewinder* missile.

$575,439—**Federal Electric Corp.**, Paramus, N.J., for range engineering services.

$439,215—**LTV Vought Aeronautics Div.**, Dallas, for target drone support services.

$408,670—**Kentron Hawaii, Ltd.**, Honolulu, for manning of various tracking stations.

$375,963—**N.T.W. Missile Engineering, Inc.**, Los Angeles, for dummy guided missiles.

$242,865—**Thiokol Chemical Corp.**, Denville, N.J., for *Bullpup* engine production.

$60,000—**Alden Hydraulic Laboratory, Worcester Polytechnic Institute**, Worcester, Mass., for studies and tests to determine missile behavior.

$48,980—**Massachusetts Institute of Technology**, Cambridge, Mass., for research and further studies related to development of an underwater missile depth control system.

$48,212—**Martin Marietta Corp.**, Orlando, Fla., for an evaluation of *Bullpup* missile improvements.

$47,350—**Gulf Aerospace Corp.**, Houston, for subcarrier discriminators.

$40,500—**American Machine & Foundry Co.**, Greenwich, Conn., for a mobile photographic tracking system.

NASA

$140,968—**American Cyanamid Co.**, Wayne, N.J., for research and development on high-performance lightweight electrodes.

$114,190—**A. J. Peters & Sons**, San Jose, Calif., for auxiliary systems for the Mach 50 helium tunnel at Ames Research Center.

$99,973—**Bendix Corp.'s Bendix Products Aerospace Div.**, South Bend, Ind., for a continued study of a shock-absorbing device that would permit a soft landing by a spacecraft on the Moon.

$85,171—**Exotech, Inc.**, Alexandria, Va., for research on optical instrumentation to detect meteoroid impact and puncture.

$57,500—**IT&T Corp., Federal Laboratories Div.**, Nutley, N.J., for a narrow band modulator.

$49,443—**Geophysical Institute of the University of Alaska**, Fairbanks, for operation of the existing network of cosmic noise radio-absorption installations.

$43,600—**Kalmia Construction Co.**, Silver Spring, Md., for construction of a bi-propellant test facility.

$25,887—**Montana State College, Electronic Research Laboratory**, Bozeman, Mont., for study of FM modulator threshold reduction

INDUSTRY

$5,000,000—**Radio Corp. of America's RCA Victor Co., Ltd.**, Montreal, from **Canadian Dept. of Transport** for an advanced ground station for use in space communications via both intermediate altitude, random-orbit satellites and high-altitude synchronous-orbit satellites. Operational tests to begin in 1965.

$1,500,000—**International Telephone & Telegraph Corp., Chicago Div.**, from **North American Aviation, Inc.**, for an in-flight electronic test system to trouble-shoot *Apollo* spacecraft malfunctions during manned lunar missions. Manual operation will allow prime use of human rather than machine decisions.

$700,000—**CG Electronics Div. of Gulton Industries**, Albuquerque, N.M., from **General Electric's Apollo Support Dept.**, for construction of the data transmission system for Project *Apollo*.

$645,000—**TRW Space Technology Laboratories**, Redondo Beach, Calif., from the **Jet Propulsion Laboratory**, for development, testing and proving of the design of a new variable-thrust liquid-propellant engine.

$533,000—**Advanced Technology Laboratories**, Mountain View, Calif., from **United Technology Center**, for work in connection with the first stage rocket motors of the *Titan III-C*.

$100,000—**Mobile Rentals Corp.**, Los Angeles, from the **Boeing Co.**, for transportable office structures for use at *Minuteman* sites.

$51,000—**Controlled Products and Electronics, Inc.**, Huntington Park, Calif., from the **Boeing Co.**, for *Minuteman* missile assemblies.

Hercules Powder Co., Wilmington, Del., from **United Technology Center**, for the design, development, evaluation and qualification of explosive devices for the *Titan III-C* solid-propellant booster (undisclosed amount).

Computer Control Co.'s Western Div., Framingham, Mass., from **Jet Propulsion Laboratory**, for three Alpha Scattering Experiment Data Translators (ASEDT) (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Systems Engineering Group, RTD
Wright Patterson AFB, Ohio
45433

Design, manufacture and installation of one furnace for vacuum heat treatment and vacuum sintering of experimental refractory metals. This unit will be capable of handling large pieces of 10" x 10" x 24". Hot zone up to 200 pounds of sustained temperatures up to 4,200° F at a maximum allowable pressure of 0.01 micron. Requests for RFQ must be made in writing. RFQ C-6397-RB. Attn: SEKRB.

U.S. Army Missile Command
Redstone Arsenal, Ala.
Attn: Directorate of Procurement and Production
(AMSMI-ISPM)

Negotiations will be conducted with Raytheon Co., Missile Systems Div., Boston, for design and development of a ballistic missile target system. All inquiries relative to subcontracting are to be referred to the above contractor.

Procurement and Production
R&D Contracts Div.
Laurence G. Hanscom Field
Bedford, Mass.
01731

Modification of contract AF 19(628)-2915 to perform design of new communications devices especially devised to be suitable for rapid deployment to advanced tactical bases. To be negotiated with Laboratory for Electronics, Inc., Boston. PR ES-4-482L-40626. Note: For information only, no RFP available.

Systems Engineering Group, RTD
Wright-Patterson AFB, Ohio
45433

Development of manufacturing technology for abricating infiltrated tungsten composite rocket ozzle inserts capable of withstanding temperaures of 7,000° F for 200 seconds. Requests for RFP must be made in writing. RFP-TB-4-MMP-143-RB. Attn: SEKRB.

Procurement Deputy Chief of Staff Material
Air Proving Ground Center (PGKK)
Eglin AFB, Fla.
32542

A continuation of effort under contract AF 8-(635)-2824 for experimentation and research n lethality of special fragments with ITT Reearch Institute, Chicago, is contemplated. This is or information purposes only. No RFP available.

Bureau of Naval Weapons
Washington, D.C.
20360

Design, develop, fabricate and furnish three requency indicators. The Bureau contemplates ward of a contract to American Electronics aboratories, Colmar, Pa. Award will be made to rmalize an unsolicited proposal in the contination of a development program now in progress ith the above firm. ote: For information only. C/N 2318-64. Bueps Synopsis No. 333-64.

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Industry Leaders & Major Contracts

3 Industry Analysis
Manufacturers, R & D Efforts ☐ Basic Materials, Suppliers, Growth Potential.

4 Technological Trends
Methods of component & circuit fabrication ☐ Manufacturing—automaticity, reproducibility, packaging, testing, yield, reliability ☐ Operating or environmental problems

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Industry and government viewpoints.

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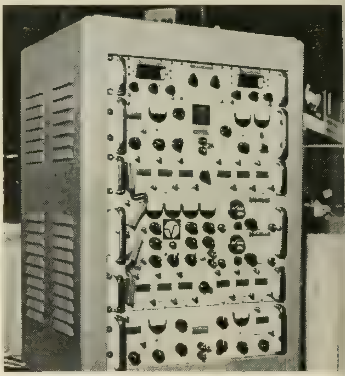
Over 44,000 missile/space engineers will read this issue
to see how microelectronics is going to affect their industry.

ADVERTISING CLOSES: JANUARY 13, 1964

MICROELECTRONICS

PUBLICATION DATE: FEBRUARY 3, 1964

New Product of the Week: Receiving/Recording System



A solid-state, dual-channel telemetry receiving and recording conversion system is being marketed by Vitro Electronics Div. of Vitro Corp. of America.

The unit includes two telemetry receiving systems, coupled with the predetection conversion equipment for recording purposes, predetection diversity combining, spectrum display and a choice of six IF bandwidths per telemetry channel. Vitro says the system requires 70% less rack space and power than comparable units.

The dual-channel telemetry receiver features two receiver channels in 7 in. of rack space. RF heads and IF demodulators are packaged in interchangeable modules and plug into the main chassis of the receiver for coverage of all IRIG RF frequencies and IF bandwidths.

Circle No. 225 on Subscriber Service Card

Waveguide Isolators

E & M Laboratories has available a series of high isolation waveguide isolators in 12 typical units.

The series provides a minimum isolation of 50 db over a 1,400-mc range, 60 db over a 1,000-mc range and 70 db over a 400-mc range. Insertion losses are 1.1 or 1.2 db maximum. All units have a 1.10 maximum VSWR and are rated for a 10-kw peak power lever, 10 watts average.

Circle No. 226 on Subscriber Service Card

Frequency Resonators

Accurate Instrument Co. has developed the PM-010 series of frequency resonators designed for stable frequency sources at extreme environmental conditions. Packaging is ⅝ x $1\frac{5}{16}$ x ⅝ in. and weight is less than 0.75 oz.

Expanded frequency range is 2 to 50 kc. Accuracies are from 0.001 to 0.2%. Temperature range is —55° to 125°C. Stabilization time is 3 seconds.

Circle No. 227 on Subscriber Service Card

Diode Test Instrument

An automatic tester that can be pro- grammed for incoming and production line inspection of diodes and low-power rectifiers has been developed by Teradyne, Inc.

The Model D157 has 10 selector knobs that establish values for reverse current and forward voltage tests within the following limits: reverse currents I (maximum) from 0.012 to 1,000 microamperes, with 12 dial settings of 1.2 to 10 and multiplier settings of 0.001 to 100; bias voltages from 0 to 599v in one-volt increments; forward voltages of 0 to 1.19v in 10 millivolt steps; and bias currents of 0 to 1,099 milliamperes in one-milliampere increments.

No adjustments are required for establishing a program or changing from one dial setting to another. Inspection rates are 2,000 to 3,000 diodes per hour

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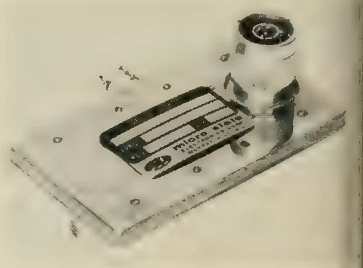
S-Band Active Limiter

Micro State Electronics Corp. i marketing the Model S-3301 S-Band Active Limiter, designed to give an iso



lation of greater than 40 db over 3,100 to 3,500-mc frequency range Nominal loss is 1 db. Input VSWR ove the range is 1.1. Switching bias voltag for the high isolation characteristic i 50 to 100 ma at —50v.

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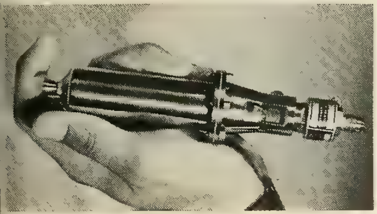
777 Metropolitan Bank Building, Dept. MR-3
Miami, Florida 33132

Circle No. 12 on Subscriber Service Card

Control Rocket

Rocket Research Corp. is marketing a 5-lb. thrust monopropellant hydrazine control rocket. Applications include attitude control, rendezvous, station-keeping, rocket belt, orbit trim and docking.



The rocket, designed for multiple starts and pulsed operation, uses an ambient temperature spontaneous catalyst. Advantages over other systems include ease of handling and storage, greater stability and system weight savings of up to 30%.

The thrust chamber is 6 in. long and weighs 0.5 lbs. Thrust levels from 0.5 to 500 lbs. can also be provided.

Circle No. 230 on Subscriber Service Card

Micromultimeter

Kin Tel Div. of Cohu Electronics, Inc., is marketing the Model 208R micromultimeter, said to be five laboratory instruments combined into one.

The device includes the advantages of a dc microvoltmeter with ranges to 1,000v, a microammeter, a wide-range ohmmeter, an electronic galvanometer and a narrow-band dc amplifier. Two scales on the unit indicate all measurement functions.

The device provides voltage measurements from 10^{-6} to 10^{3} dc; current measurements from 10^{-10} to 10^{-1} ampere dc; resistance measurements from 10^{-3} to 10^{9} ohms. Accuracy is 1% of full scale or 10% of most sensitive ranges. The unit operates from 115 or 230v, 50 to 400 cps.

Circle No. 231 on Subscriber Service Card

VSWR Detector

Telonic Engineering Corp. has available a Rho-tector VSWR measuring instrument capable of providing a minimum of 50 db return loss error.

The Model TRB-3 is basically an impedance comparator, utilizing a frequency-insensitive RF bridge with a detector circuit. The device can determine VSWR from 1 to 1,000 mc and is optimized for operation at a 50-ohm impedance level. It has a 50-db loss error from 1 to 800 mc and 45 db from 00 to 1,000 mc.

Output polarity is negative, time constant is 10 microseconds and maximum power input is 0.5 watts.

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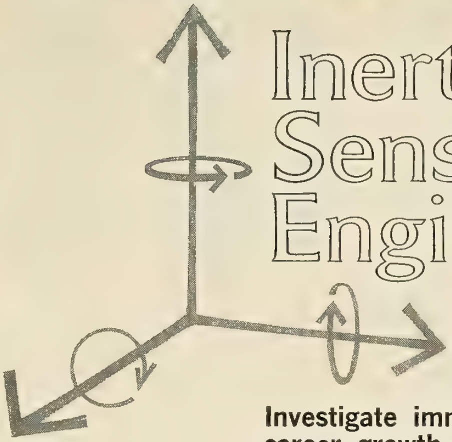

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INERTIAL SENSOR/INERTIAL COMPONENT

Design Engineer — BSME/EE. Three or more years experience in development and testing of gyros/accelerometers. Familiarity with electronic instrumentation techniques (including pulse circuits) and servo-mechanism practice. Knowledge of electromagnetic components, i.e., gyro torquers, pickoffs, etc.

Design Engineer — BSME. Three or more years experience in design of floated gyros/accelerometers for guidance applications. Familiarity with gyroscopic principals and applicable design analysis techniques. Able to design and conduct investigations pointed toward improving performance and producibility from a production standpoint. Knowledge of gas-bearing lubrication techniques desirable.

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names in the news

SKONBERG

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MARTIN

Albert W. Skonberg: Appointed district manager for applied products of Aro Corp., Bryan, Ohio.

Fred A. Best: Named director of sales-engineering of the AC Spark Plug Div. of General Motors Corp., Milwaukee. **Alvin B. Goodspeed** named director of materiel.

Louis L. Frank: Appointed director of marketing for the Physics Research Div. of Geophysics Corp. of America, Bedford, Mass.

E. W. Foote: Elected vice president-marketing of Canoga Electronics Corp., Chatsworth, Calif.

George F. Newman, Jr.: Appointed assistant treasurer of the Hewlett-Packard Co., Palo Alto, Calif.

Robert C. Gormley: Promoted to business manager of Vitro Corp.'s Silver Spring, Md., laboratory.

John A. Johnson: Appointed director of international arrangements for Communications Satellite Corp., Washington, D.C.

James O. Wright: Elected president of Federal-Mogul-Bower Bearings, Inc., Detroit.

Burgess Dempster: President of Electronic Engineering Co. of California, Santa Ana, elected president of the Western Electronic Manufacturers Assn.

A. G. Williams: Elected vice president of Antenna Systems, Inc., Manchester, N.H.

Robert F. Martin: Named manager of quality control by Electralab Electronics Corp., Encinitas, Calif.

Robert M. Engler: Appointed production manager for Barry Controls' eastern operations, Watertown, Mass.

Dr. G. Lloyd Martin: Appointed general manager of the Research Div. at National Research Corp., Cambridge, Mass.

Dr. Zvi Prihar: Named director of advanced communications systems for Philco Corp.'s Communications and Electronics Div., Philadelphia.

Harry Stern: Appointed sales manager, electro-mechanical devices for the Explosives and Chemical Propulsion Dept. of Hercules Powder Co., Wilmington, Del.

John C. Washington: Appointed director of marketing for Robertshaw Controls Co.'s Aeronautical and Instrument Div., Anaheim, Calif.

Robert Feldman: Appointed sales engineer for Eldon Fiberglass Mfg. Co., Compton, Calif.

Norman Houlding: Appointed manager of the Advanced Development Dept. of National Co., Inc., Malden, Mass. **Walter Schreuer** appointed manager of the Communications Development Dept.

Kenneth M. Howard, Jr.: Joined the Space Engineering Laboratory of the Aero Geo Astro Corp., College Park, Md., as a technical advisor on space activities.

Lloyd F. Bielenburg: Named assistant secretary of Eitel-McCullough, Inc., San Carlos, Calif.

Dr. Frederick K. Mueller: Appointed chairman of the board of Astro-Space Laboratories, Inc., Huntsville, Ala. **Joseph C. Brenner** named vice president and general manager.

George W. Eichman: Named directo of marketing for the General Engineerin Div. of American Machine & Foundry' Advanced Products Group, Stamford Conn.

James H. Kirkendall: Appointed contracts administrator and administrative engineer for the Aerospace Div. of Gree Hydraulics, Inc., Los Angeles.

Arthur A. F. Aschauer: Named executive assistant to the senior vice president marketing at Univac Div. of Sperry Ran Corp., New York City.

Bernie E. Zettl: Appointed director o program planning for Dynalectron Corp Washington, D.C.

Carl M. Hanson: Named head of th Douglas Missile and Space Systems Div. office at Hampton, Va.

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MECHANICAL PLANT ENGINEER

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AERONAUTICAL ENGINEER

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—when and where—

DECEMBER

Nobel Festivities and Nobel Prize Ceremony, Stockholm, Sweden, Dec. 10.

Electronic Industries Association Microelectronics Conference, Philadelphia, Dec. 10-11.

SAE Committee Meeting on Spacecraft Flight Controls, Houston, Dec. 11-13.

AIAA Conference on Heterogeneous Combustion, Biltmore Hotel, Palm Beach, Fla., Dec. 11-13.

National Vendors Meeting, Space and Flight Equipment Associations, San Diego Aerospace Museum, San Diego, Calif., Dec. 13-14.

The 60th Anniversary of Powered Flight Observance Program, Kitty Hawk, S.C., Dec. 15-17.

Conference on Non-Linear Processes in the Ionosphere, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Dec. 16-17.

Wright Memorial Dinner, Sheraton Park Hotel, Washington, D.C., Dec. 17.

American Physical Society Meeting, Pasadena, Calif., Dec. 19-21.

American Astronomical Society Annual Meeting, College, Alaska, Dec. 26-28.

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On Muddy Problems

THERE IS NO OFFICE in the Pentagon which comes under as much industry fire as the Directorate of Defense Research and Engineering. One of the most common complaints is that, in an unrealistic scientific approach to military problems, it is trying to find solutions by analysis instead of engineering.

It is most refreshing, therefore, to discover one of the top DDR&E officials coming out in favor of what he himself calls old-fashioned engineering. Dr. Eugene Fubini, deputy director of DDR&E, delivered to the American Ordnance Assn. in New York last week a speech which was a clear and succinct challenge to the industry not only for old-fashioned engineering, but for some new-fashioned thinking.

At the same time, he offered a solution to a problem which already is beginning to concern the leaders of both the industry and the nation—the areas the defense industry can turn its attention to as the major demand for intercontinental ballistic missiles begins to slack off (see p. 16).

Dr. Fubini's speech was evidence that some pretty clear new-fashioned thinking has, in fact, been going on in the top levels of the defense and engineering directorate.

The DDR&E deputy pointed out that in the four major developments which have revolutionized warfare in recent years—nuclear weapons, the ballistic missile, the true submarine, and command and control systems (including sensors)—the United States has maintained a clear lead. For this reason, he said, the technical problems related to central nuclear war, even if they are not all solved, are no longer the most critical.

"Clearly, we are still working and must be working on the 'counters'—counter missiles, counter submarines, counter bombs and counter radars—because if the defense caught up with the offense, another technological cycle of extreme importance would begin all over again," Dr. Fubini said.

But he recognized the fact that national survival no longer immediately depends, as it used to, on the development of the weapons for strategic nuclear war. Obviously, we must continue work in this area to guard against technological surprise, both from an offensive and defensive standpoint.

But the DOD official suggested that current methods for developing strategic weapons may be totally inadequate for assuring breakthroughs in conventional warfare.

Speaking of limited non-strategic warfare, Dr. Fubini said:

"New, unmatched challenges appear in this area. We find we have a lot of things to do. In some areas, we even need to recover some ground because we have retrogressed from where we were in World War II. We need to use our ingenuity and our intelligence to deter, and if necessary, to win these wars as well. Not enough revolutionary technical thinking has been devoted to these conflicts."

As the DDR&E deputy sees it, an entirely new situation has evolved. Since strategic wars can be centrally aimed and centrally controlled, a few very expensive, very sophisticated systems are necessary and justified for these. But, for limited warfare, there is a need for hundreds or thousands of lower-cost and less-complicated items.

The industry thus may be facing a return, to some extent, to the days when companies spent their own money to develop a weapon and made the profit out of production—the years when R&D and engineering were considered overhead items and production was what mattered.

What Fubini is seeking is something that has not yet been done, the application of modern technology to conventional warfare problems on a massive scale. He has coupled this appeal for fresh thinking in R&D with a brief for simplicity and sound engineering.

"Old-fashioned engineering may come back in vogue," he said, "because one cannot have simplicity without good engineering. To make things simple takes a lot of ability and this is going to be the most important and the most difficult challenge facing us."

He cited the *Sidewinder* missile, built by Philco and General Electric as one in which simplicity is the key both to quantity production and tactical use. *Sidewinder* was developed at the Naval Ordnance Test Station in China Lake, Calif.

THE DDR&E OFFICIAL listed some specific projects which he would like to see the industry tackle. Two of the most interesting:

- An air-to-surface missile with an accuracy of a few feet against point targets many miles away, so accurate that high explosives could be used to destroy tragets previously requiring nuclear warheads.
- Mud—and the methods by which this age-old problem of the foot soldier might be overcome or turned to advantageous use. "Why not devote some of our industrial capabilities to the problem of mud? The Army has a modest mud research program, but how many industrial or chemical firms have looked at the basic problem? How many engineers who design cars, trucks, and tanks have asked themselves: What is mud? What makes mud behave the way it does? How many different kinds of mud are there? Can their properties be modified?"

Dr. Fubini even suggested some rethinking about standardization, questioning whether standardized specifications should be equivalent to universal specifications. It may be, he pointed out, that expecting a given piece of equipment to function equally well in the Arctic, the tropical jungles, the desert and in temperate regions is more costly than specializing for the environment.

We hope the industry will both applaud and heed Dr. Fubini's challenging words. The speech was one of the finest to come out of the Pentagon, and particularly significant in its origin in the Directorate of Defense Research and Engineering.

William J. Coughlin

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DECEMBER 16, 1963

nissiles and rockets

IE WEEKLY OF SPACE SYSTEMS ENGINEERING

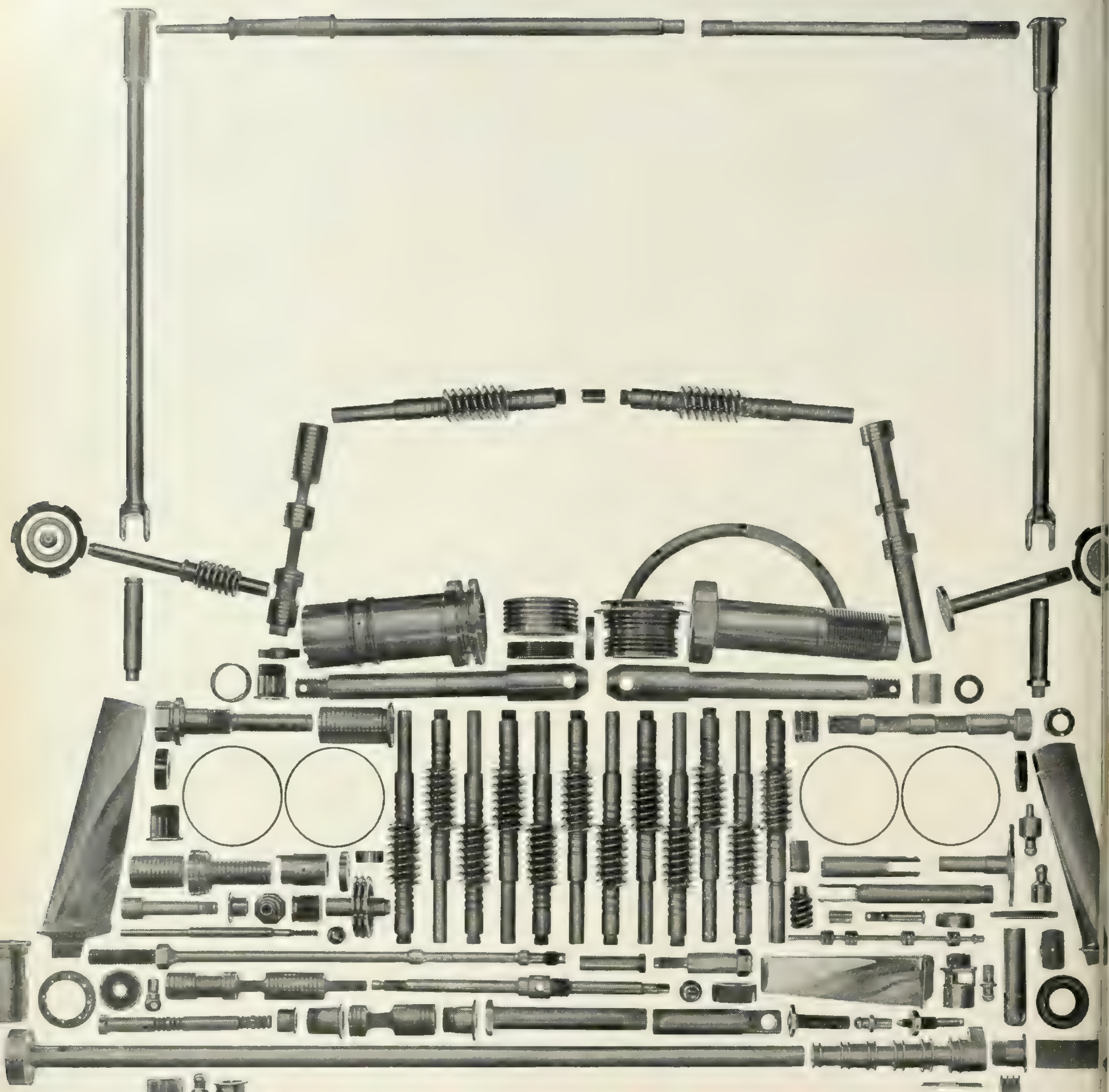
-2 Engine on Rocketdyne Production Line

AF GETS MOL, LOSES DYNA-SOAR—

Industry Awaits Action on Proposals . .

Congress Gives Tentative Support . . . .

X-20 Loss Stirs New Interest in X-15 . .



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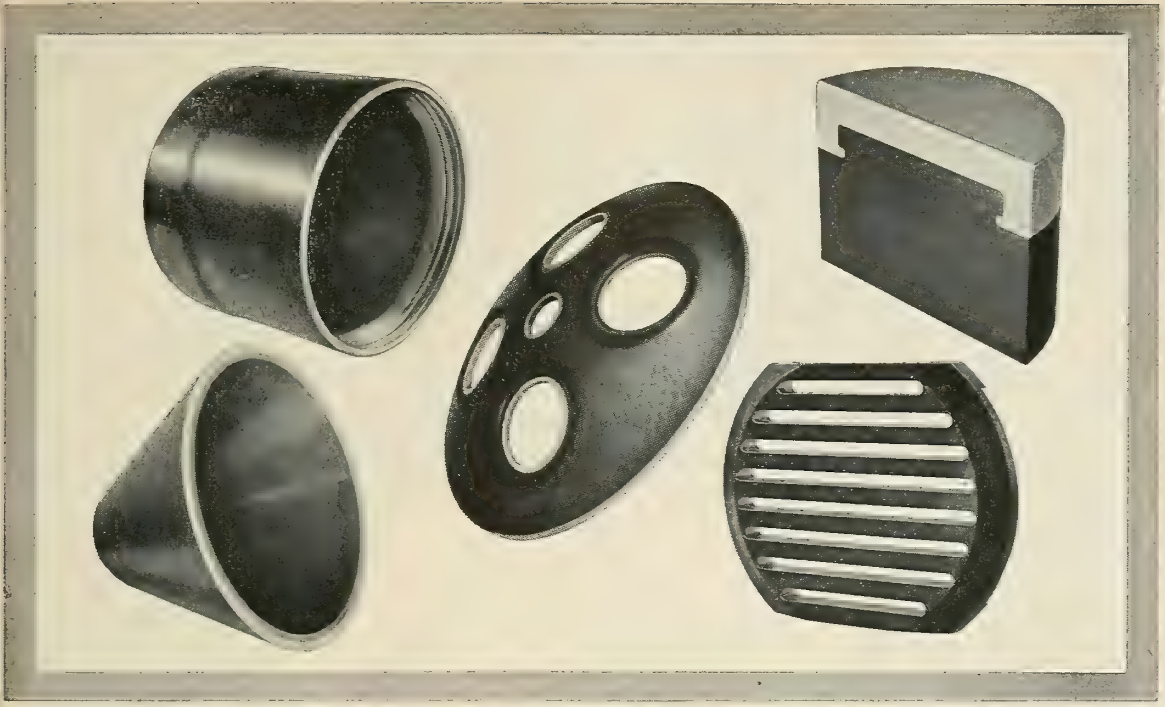

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Time Sharing

Co-op Computers?

As computers become more common in large organizations, the question arises as to whether one large computer or a number of smaller ones should be obtained. For many applications, it is desirable to make the computer itself accessible to the individual user, engineer, or manager. Normally, economy of operations dictates that the large computers are used in a centralized facility where they are unavailable to the potential user. Thus, many organizations are forced into procuring several small computers to service them. A potential answer to this dilemma lies in the time-sharing approach, wherein computer programs are so arranged that several individual users may have simultaneous access to the computer. Substantial man-hours can be saved by on-line checking of new computer programs, and certain functions become feasible when users are in direct communication with the computer. SDC is developing such a time-sharing system within the Command Systems Department, and a large computer, the AN/FSQ-32, is currently in operation in a time-sharing mode at SDC. The technology of time sharing is but one of many aspects of tomorrow's information systems now under scrutiny by SDC scientists and engineers. This broadening spectrum of systems technology will create a wide range of unusually attractive positions at SDC. Human factors scientists, operations research scientists, systems-oriented engineers, and computer programmers interested in joining a rapidly expanding technology are invited to write Mr. A. M. Granville, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Massachusetts; and Dayton Ohio. "An equal opportunity employer."

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Volume 13, Number 25 December 16, 1963

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THE COVER

Thrust chamber of J-2 hydrogen-fueled rocket engine on production line at Canoga Park, Calif., plant of Rocketdyne Div. of North American Aviation, Inc. A single 200,000-lb.-thrust J-2 will power S-IVB stage of Saturn IB and Saturn V. Five will be used on second stage of Saturn V.

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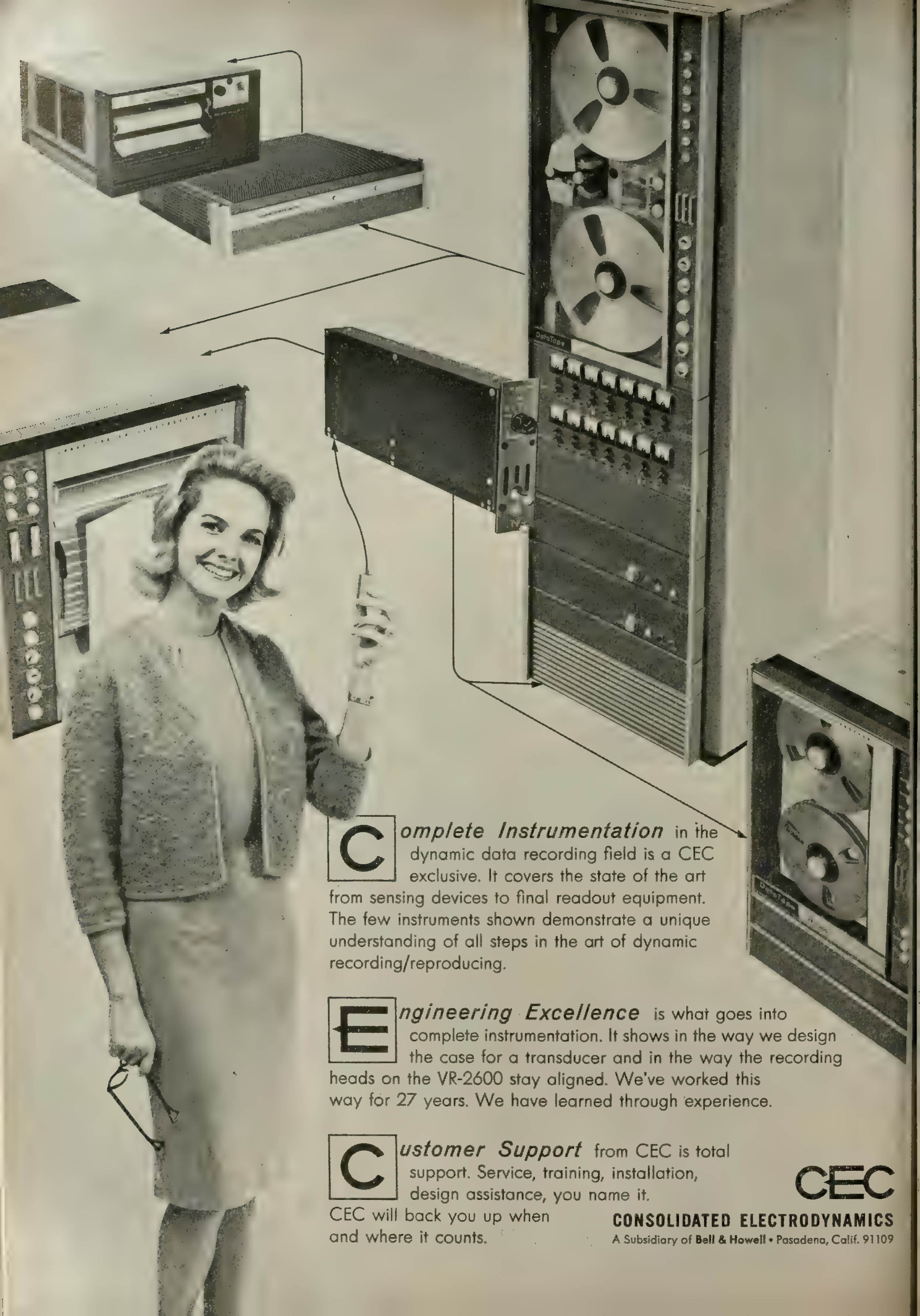
47,600 copies this issue



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letters

Grand Old Name

To the Editor:

Your Dec. 9 issue reports that naming the John F. Kennedy Space Center for the late President met with universal approval but that the decision changing Cape Canaveral to Cape Kennedy was received with hostility by some residents in the area.

Based on letters written to the editors of local newspapers and on personal contact with many people, I believe you will find that the attempt to erase the name of Cape Canaveral in favor of Cape Kennedy has met with universal disapproval. Cape Canaveral was named more than 400 years ago, and it is linked with the earliest history of European exploration of the continent. Cape Canaveral has become world-famous as the site of our earliest missile and space flight efforts, and the name should be preserved.

President Kennedy expressed a deep respect for history, and I do not believe that he would agree with the attempt to change the old and famous name of Cape Canaveral.

Harley Tompkins
Winter Garden. Fla.

Apollo and Saturn I

To the Editor:

I have read with interest the Letter to the Editor in the Dec. 2 issue of M/R from Mr. John B. Stevenson, of Wickliffe, Ohio, arguing for the retention of the previously scheduled *Apollo-Saturn I* flights, now cancelled by NASA.

I, too, can appreciate the expressed impatience of Mr. Stevenson. But, more important, hasn't he expressed a very valid proposition?

My interpretation of *Apollo/Saturn* schedules tells me that this proposal (to use the ascent stage of LEM, the command module and a service module scaled down in weight aboard *Saturn I* to attain the same results planned for the *Apollo-Saturn IB* flights) could be carried out possibly in the early part of 1965.

If the LEM could be ready in regard to ascent stages at this time, the accomplishment of the proposal would be a definite boon to the program.

I know that the Air Force would welcome a more active role in *Gemini* than it now appears that we may get.

Michael E. Mulligan
Lt., USAF
Rancho Cordova, Calif.

Maybe it will get it. See pp. 14 & 54.—Ed.

Silica Reflectors

To the Editor:

I would like to take this opportunity to congratulate Mr. William Beller for his excellent article, "Fused Silica Reflectors in Laser Test" (M/R, Oct. 21, p. 29).

I feel that if the *S-66* experiment is successful, we are going to hear a lot about corner cube reflectors and laser tracking devices. There are presently several programs under way involving their use. They are being used in Doppler measurement experiments and in Laser Q spoiler circuits, also in a satellite-to-satellite tracking system. We have fabricated, or are presently fabricating, the prisms for these experiments.

Cyril J. Broomer
Assistant to the President
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The Countdown

WASHINGTON

Lunar Decision Due This Week

Decision as to whether the U.S. will hold to its goal of landing astronauts on the Moon by the end of this decade will be made this week. NASA officials are going to appeal to President Johnson for $5.8 billion—in the FY '65 budget or divided between the FY '65 budget and a FY '64 supplemental. Thus far the Budget Bureau has balked at that figure, which the space agency says is necessary to meet the *Apollo* goal. Chances for a supplemental appropriation in the current year are not good. One solution could be a FY '65 budget of $5.3 to $5.5 billion and then a FY '65 supplemental request after the Presidential election.

McNamara Says He Will Stay at DOD

Secretary of Defense Robert McNamara told newsmen last week that he will stay in his post for as long as President Johnson wants him.

NASA and DOD Settle Ship Dispute

NASA and Dept. of Defense have signed an agreement settling their dispute over the *Apollo* program tracking ships. Agreement gives DOD, through the Navy's Military Sea Transportation Service, responsibility for operation and construction of the ships. NASA has the responsibility for determining the mission of the ships as well as procuring and setting the specifications for their instrumentation. (See story, p. 17).

Air Force Will Finish Dyna-Soar Facility

Air Force officials say construction of the *Dyna-Soar* Research Laboratory Building at the John F. Kennedy Space Center will be completed. The building now is 25% finished. It's expected that it will be used in the new *Gemini X, MOL* program. Cancellation of the *X-20* project will affect 20 to 30 Boeing employees at the Cape, but the company says it will find jobs for them in its other operations.

Tiros 8 Is Set to Go This Week

Tiros 8 launch still is scheduled for Dec. 17 in the first test of the Automatic Picture Transmission (APT) subsystem. Some 40 ground stations will take part in the experiment by receiving cloud-cover pictures from the orbiting satellite. Six will be NASA stations. Two foreign stations, one French and the other manned by the International Indian Ocean Expedition, also will take part.

NASA Winds Up Used Car Probe

NASA has completed its investigation into alleged wrongdoing by some agency personnel and industrial contractors in the purchase of cars formerly rented by the space agency. Report now is in the hands of Kurt Debus, director of the Kennedy Space Center. It will be released as soon as he makes a decision on whether some personnel changes are necessary.

INDUSTRY

AMF Sets Move to Pennsylvania Plant

American Machine & Foundry will pull its entire Advanced Products Group out of its Greenwich and Stamford, Conn., locations for a move into a newly acquired facility in York, Pa. Move into the former naval ordnance plant, purchased for $9.6 million by AMF, is expected to be completed in February. Advanced Products Group accounted for about $75 million in sales in Fiscal 1963.

Sundstrand Seeks Use for X-20 Unit

Sundstrand Aviation is investigating other possible applications for the cryogenically fueled power unit developed for *Dyna-Soar*. Two of the units, which provide both electrical and hydraulic power for a space vehicle, already have been delivered to Boeing and others are undergoing flight qualification testing in Denver. Sundstrand held a contract worth more than $10 million for the *X-20* accessory power unit.

Doolittle Named to Aerospace Board

Lt. Gen. James H. Doolittle, USAF (Ret.), was elected a member of the board of trustees of Aerospace Corp. last week, succeeding the late Trevor Gardner, president and chairman of the board, Hycon Manufacturing Co. Doolittle also is a director of Space Technology Laboratories.

Grumman Seeks LEM Truck Development

Grumman Aircraft & Engineering Corp. has told NASA that the best way to develop the LEM Truck—which the agency is considering funding—is concurrent design of the truck and the LEM descent stage. The firm also maintains that it has the personnel to handle both jobs at the same time.

Rocket Power To Make Seeding Rockets

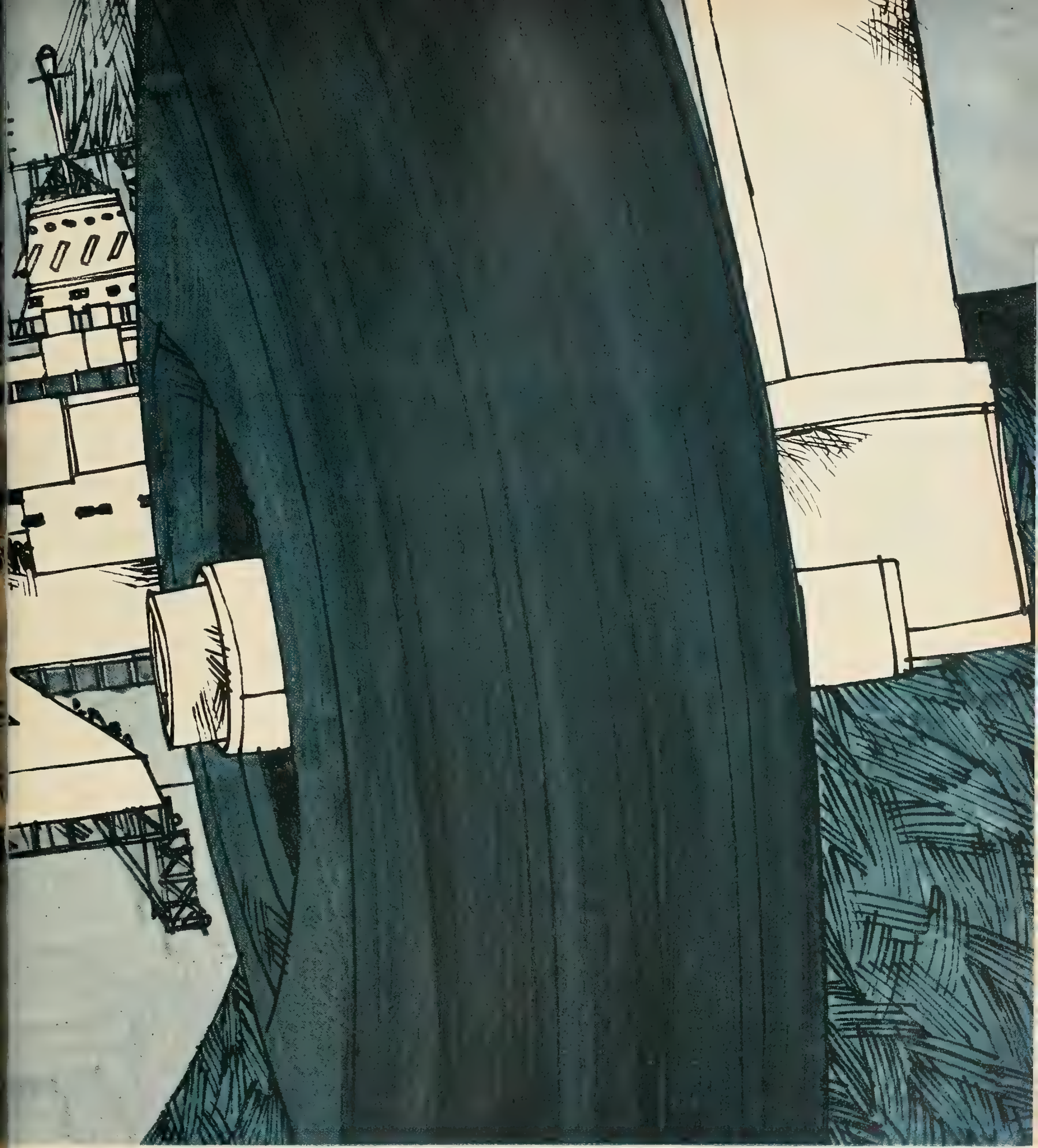
Rocket Power, Inc., will make 50 small solid-propellant rockets which will be used to seed Arctic fog and clouds with dry ice in an attempt by the Army to develop a way of dissipating "white-out" conditions. Each rocket will carry a pound of crushed dry ice and will disperse it at a low altitude. White-out is a condition in which snow, fog and overcast combine to wipe out all visual references, causing the eyes to focus incorrectly, reducing depth perception and producing vertigo. Contract was awarded by the Army Cold Regions Research and Engineering Laboratory.

INTERNATIONAL

Minuteman Proposal Coolly Received

A proposal from The Netherlands that internationally owned and manned squadrons of *Minuteman* missiles be based in the U.S. has met with a cool reception from the U.S. Proposal was made earlier this month before the annual meeting of the Western European Union.

We'll soon be making lunar landings possible, too.



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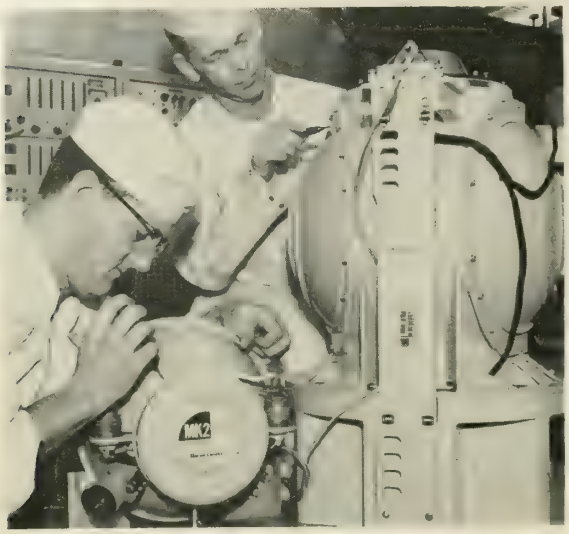


Polaris Guidance Refined

FIRST AND SECOND generation inertial platforms are shown together at Honeywell's Aeronautical Div., Minneapolis. Mark 1 (right) is last unit of its kind to be produced. Mark 2 at left is first unit developed under a Navy Special Projects Office prime contract.

Comsat Gets Boost from AT&T

American Telephone and Telegraph Co. has promised Communcations Satellite Corp. it will postpone plans to lay a new high-capacity underwater cable in the Atlantic in 1967-68 if Comsat proves it can provide the same service with satellites.

The disclosure came from Comsat board chairman Leo Welch after he received a letter from AT&T's Executive Vice President James E. Dingman. Dingman stated that AT&T hopes to have satellite communications in operation by late 1966 or early 1967. He said that if things go as planned, "We would prefer, for diversity reasons, to use satellite circuits instead of placing additional cables."

The development is viewed as a significant psychological boost for the satellite firm. Many experts have suggested that satellite communications cannot economically compete with cables for transoceanic communications business.

Details of Soviet ABM Revealed

The Hungarian Communist Party newspaper, *Nepszabadsag*, has announced what it says are operational details of the USSR's touted "fly-in-the-sky" antimissile missile.

In a survey by its military editor, the paper reports that the two-stage, 50-ft.-long missile has a range of between 2,500 and 3,750 mi. Control of the weapon is incorporated into a long-range radar system that feeds data concerning approaching missiles into computers.

The radar system then automatically relays the data to the ABM network of stations, which take over tracking. The ABM is fired automatically when the incoming missile is some 600 mi. away.

The report says that the ABM's course can be changed in flight. Effective altitude range of the antimissile missile is said to be from 20 to 200 mi.

Shots of the Week

NASA launched two rockets Dec. 7 from Wallops Island, Va. The first, a *Nike-Cajun*, carried 82 lbs. of instruments and sounding gear to a maximum 65-mi. altitude to study wind velocities and temperature at 11 different altitudes. The first shot was followed by a *Nike-Apache*, carrying 62 lbs. of pressure and density measuring devices to an altitude of 87 mi.

- A West Germany company, Weapons and Aviation Armament Corp., test fired four military rockets Dec. 5 near Cuxhaven, Germany. Shots were observed by some 100 invited spectators, including military attachés of Jordan and Saudi Arabia. (See p. 21.)
- The Navy on Dec. 9 successfully fired a *Polaris A3* from a Cape Kennedy land pad.
- NASA's *X-15* rocket plane was flown Dec. 5 in a test of high-speed, high-altitude reconnaissance photography. Air Force Maj. Bob Rushworth flew the craft to an altitude of 105,000 ft. at a speed of 3,900 mph. Major objective was to determine distortion effect of supersonic air layers on photographs.
- A *Polaris A3* fired from the USS Observation Island Dec. 11 while the ship was cruising some 30 mi. east of Cape Kennedy was destroyed by the range safety officer 53 seconds after launch. The missile had wandered off course.
- An Air Force *Thor-Able-Star* booster has lifted the nation's second satellite completely powered by nuclear energy into orbit from Vandenberg Air Force Base, Calif. An Atomic Energy Commission announcement, which gave no date for the launch, said signals from the military satellite are being transmitted with electricity from a *SNAP-9A* radioisotope generator. The *SNAP* system was developed by Martin Company's Nuclear Div. for the AEC.

Launch of the earlier all-nuclear satellite was announced by the AEC Oct. 1 (M/R, Oct. 7, p. 18).

U.N. Reaches Space Agreements

The United Nations General Assembly political committee on Dec. 5 adopted legal principles for the use and exploration of "outer" space.

The resolution had been drawn up by the U.S. and the Soviet Union along with a declaration calling for cooperation in scientific projects and on legal matters.

Agreement on the principles does not constitute any sort of space law but it is viewed as the forerunner of specific treaties dealing with such problems as liability for space accidents and the safe return of astronauts and space vehicles.

35 Bases Face Shutdown

It was reported last week that the Defense Dept. planned to close 35 U.S. military installations employing 75,000 civilians.

A Congressional source said that Secretary of Defense McNamara would make an official announcement on the subject within a day or two

Among installations reportedly to be shut down were seven in New York State employing 11,000 persons. Among them were the Rome Air Materiel Area and the Schenectady Army Depot.

Earlier in the week the Defense Dept. announced plans to close naval shipyards in San Francisco, Boston and Philadelphia as part of the new military economy drive. Other shipyard shutdowns were rumored to be under consideration.

AF Names New PIO Chief

Maj. Gen. Eugene B. LeBailly has been appointed to replace Maj. Gen. William K. Martin as Director of the Air Force Office of Information. Martin will become Assistant Deputy Chief of Staff, Personnel.

Brig. Gen. George S. Boylan, Jr., formerly Deputy Director of the Air Force Aerospace Programs in the Pentagon, will replace Gen. LeBailly.

Yeager Abandons Rocket Plane

Col. Charles Yeager, Commandant of the Aerospace Research Pilots School at Edwards AFB, Calif., sustained first and second degree burns on his face, neck and left hand before bailing out of a disabled rocket-augmented NF-104A aircraft Dec. 10.

Yeager was making a familiarization flight in the craft prior to a scheduled Dec. 12 attempt at an altitude record.

He ejected at 10,000 ft. after the plane failed to recover from a flat spin from 90,000 ft.

The plane went into a spin after power had been cut off for the arc phase of the zoom flight, and the engine was never restarted.

U. of Minnesota Gets POCIBO

The National Science Foundation has awarded a $393,000 grant to the University of Minnesota to conduct studies on the Northern Lights and cosmic rays from space.

The project, called POCIBO, for Polar Circling Balloon Observatory, will be conducted with 20 or more large instrument-carrying balloons encircling the North Pole.

The balloons, each with a volume of 1.5 million cu. ft., will be launched from the Arctic research laboratory in Pt. Barrow, Alaska, and fly at an altitude of about 100,000 ft.

MILA Tract Nearly Complete

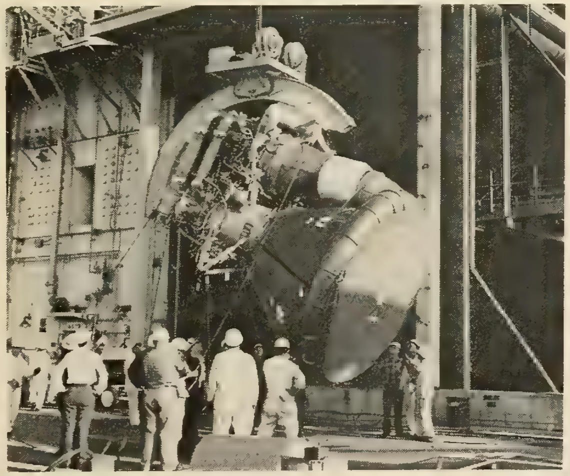
The Army Corps of Engineers says its land-acquisition program at NASA's Merritt Island Launch Area (MILA) will be completed by the end of this month—60 days ahead of schedule.

Acquisition of the entire 88,000-acre tract before Jan. 1 will save current owners county taxes assessable as of that date.

The first building completed at MILA was scheduled for occupancy Dec. 13. The structure will serve as headquarters for the resident engineer and his staff, who are in charge of constructing the $75-million industrial area facilities.

MILA is part of the John F. Kennedy Space Center, but lies just north of the former Cape Canaveral, the land area that now bears the late President's name.

Saturn V's Horses



FIVE ENGINES uch as this Rocketdyne F-1 will provide a total of 7.5 million lbs.' thrust or the Saturn V's first stage. First tage of SA-5 Saturn, set for launch Dec. 18, will be powered by eight Rocketdyne H-1 ngines developing .5 million lbs.' thrust.

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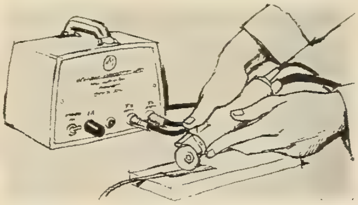

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NASA 'fully supports' . . .

MOL Study Awards Due Soon

Existing proposals for earlier OSS program expected to be basis for two or three four-month contracts; $1-3 billion may be long-range cost

by David C. Breasted

SPACE STATION PROPOSALS already in the Defense Department evaluation mill are expected to form the foundations for the *Manned Orbital Laboratory* (*MOL*) program which recast the Nation's space picture last week.

Two or possibly three study contracts will be awarded "shortly" from among earlier submissions from 10 industry teams for the Air Force's *Orbital Space Station* (*OSS*), according to an informed Pentagon source.

Expectations are that the Air Force will mesh *MOL* and *OSS* thinking within the framework of the original proposals, but the industry teams will be asked to modify their presentations of what is to be studied. Evaluators will have to examine the work statements to see how they can be changed for *MOL.*

However, an official close to the program said that any necessary changes would be relatively minor because the *OSS* RFP's and the responses were "pretty close" to what the office of the Director of Defense Research and Engineering (DDR&E) has in mind for *MOL.*

The study contracts are expected to run for four months. DOD and Air Force spokesmen could give no date for the contract awards.

Nor could officials give a firm idea down the line of when they would plan to start buying hardware, pending resolution of just what will be required.

Consensus on who would buy the *Gemini X* capsules for *MOL* leaned toward Air Force purchase because of sharply different requirements for *MOL* and NASA.

Program definition phase for *MOL* probably will run until early fall of 1964, according to first estimates.

From Defense Secretary Robert S. McNamara's tandem announcement of *MOL* and cancellation of *Dyna-Soar,* the frequently murky kaleidoscope of the Pentagon space outlook assumed these clear lines:

- **"A real chance"**—The Air Force, after years of pushing and brainstorming to define its space mission, now has "a real chance to show what it can do," as one official put it. The Air Force faces a crucial opportunity to show that military men, in fact and not merely in theory, are useful enough in space for a variety of purposes to justify the cost of putting them up and supporting them.

While the DOD emphasis in *MOL* is constantly upon the exploratory and experimental "laboratory" aspect, there is keen interest in the military possibilities of *Gemini X* itself, under the heading of "other classified projects" which McNamara referred to in answer to press questions.

These could include surveillance, inspection, reconnaissance, interception, and defense against ballistic missiles.

The United States, while possibly deferring a start towards a future, large and complex orbital space station, now is likely to be forearmed in such an undertaking with a voluminous fund of critically-important information—both through *MOL* and through the related and beefed-up *ASSET* program. (M/R, April 29, p. 30; May 27, p. 28.) The latter is billed as compensating for some loss in hypersonic research and development of re-entry shapes caused by the *Dyna-Soar* cancellation.

The *MOL* effort, by the time it is substantially completed, is likely to cost from $1 billion to $3 billion, depending on what existing or coming hardware and experiments are involved. But, McNamara stressed, the program will derive more for its money than *Dyna-Soar,* for its purposes, could have done.

MOL will have capability for more than two men, "although we wouldn't necessarily utilize all of them," McNamara revealed. Missions would be for two to four weeks.

Rendezvous capability will have to wait until the DOD high command is satisfied that the program is proving out, and that there is a clear need for rendezvous capability. This, however, will be designed into *MOL* for future use.

The military operating element, if the Air Force is successful in its effort, will be in the near-Earth region, McNamara said.

MOL is *not* the national orbiting space station program envisioned in the August agreement between McNamara and NASA Administrator James E. Webb, although the basic principles of coordinated effort are involved. *MOL* will carry certain NASA experiments, paid for by NASA, as the Air Force will do in reciprocation in the NASA *Gemini* program. But *MOL* is an Air Force show entirely.

- **Strictly experimental**—Officials stressed two general points in discussing *MOL*:

1. It is experimental, not an operational military system, built from existing hardware.

2. The whole program, as one said, "will have to be very carefully managed," under stiff management and funding demands like those imposed upon the *Titan III* launch vehicle development.

As McNamara summed up the endeavor, "despite the fact that they are not clear, we will undertake a carefully controlled and carefully scheduled program of developing the techniques which would be required were we to ever suddenly be confronted with a military misison in space, and it is for that reason that you (reporters) recall we proposed and the Congress approved the *Titan III* program.

"It is for that reason that we are proposing the manned orbiting laboratory; not for a precise, clearly defined, well-recognized military mission, but because we feel that we must develop certain of the technology that would be the foundation for manned military operations in space should the specific need for those ever become clear and apparent."

As for the *Dyna-Soar* cancellation, students of McNamara's statements and Congressional testimony, particularly since early last spring, reacted to the coup de grace with something less than consternation. McNamara's growing disenchantment with *Dyna-Soar's* cost plus its limitations had cropped out frequently for months.

"*Dyna-Soar*," he said last week, "was not intended to develop a capacity for ferrying vehicles or personnel or equipment into orbit, nor was it intended that *Dyna-Soar* would provide a capability for extended stay in orbit, nor was it intended that it would provide the capability for placing substantial payloads, useful payloads, in orbit, and hence, it had a limited objective. It was very expensive." That did it.

Limited *Dyna-Soar*, if completed, would have cost more than $1 billion. About $400 million will have been spent by the end of phase-out. With about $45 million saved from the $125 million allocated in FY '64, and including $146 million in FY 1965, McNamara figured to save about $100 million in the next 18 months.

In forecasting timetables, McNamara estimated that the first unmanned *Gemini* capsule launch would be in the first half of 1966, manned flight in the second half. Unmanned canister launches would follow in late 1967, and manned launches would go in the first half of 1968. However, possible slippages will lurk in the background.

• **NASA reaction**—Despite reports to the contrary, top space agency officials were told in advance of the DOD action and agreed to it. The discussions took place during meetings to coordinate the two agency's budgets. These sessions were attended by McNamara and his top aides, as well as by the space agency's three highest officials, Administrator James E. Webb, Deputy Administrator Dr. Hugh L. Dryden, and Associate Administrator Dr. Robert C. Seamans, Jr.

Officially, Webb said "the decisions announced by Secretary McNamara with respect to the *Dyna-Soar* project and the *Manned Orbital Laboratory* project follow discussion with NASA and were fully coordinated with the programs of this agency. The transfer of resources and objectives from the *Dyna-Soar* to the *ASSET* program will accomplish objectives important to both agencies. The decisions announced by Secretary McNamara are based on the best use of resources to maximize our national capability in space and NASA fully supports them."

The news, however, did not trickle down into the Office of Manned Space Flight, the area of NASA most concerned with the project. For example, Dr. George E. Mueller, associate administrator for manned space flight, got his first word of the action after the Pentagon announcement.

The lack of prior warning made it very difficult to get manned space flight officials to comment on the loss of the station project to the Air Force, as well as the effect of the Pentagon's decision on their own programs.

• **MORL still in the works**—A top official did say, however, that there is currently no intention to cancel the contract recently awarded to Douglas Aircraft Co. for continuing study of the *Manned Orbiting Research Laboratory*. That concept calls for a cylindrical spacecraft capable of supporting six astronauts for six months and rather larger than the DOD configuration.

The space agency said it would continue primarily because the study will provide technology useful to the AF program.

A top NASA official also told Missiles and Rockets that the DOD station is only an "elementary form." He said other space stations probably will be built, but not for a number of years.

As a result, NASA will continue to study the larger space station concept, which would be capable of sustaining up to 30 astronauts for a one-to-two-year period.

He added that while there will be some room for experiments on the DOD station, it will not have the orbiting lifetime necessary to make the so-called "g" decision. That is, whether an astronaut can survive 90 consecutive days of weightlessness.

NASA's current budget problems, however, could lead to an eventual sharp cutback in funds available for studies of advanced stations.

The agency's Office of Advanced Research and Technology (OART) also apparently is giving up any thought of an unmanned spaceflight program to provide the data which it previously hoped to get from *Dyna-Soar*.

OART officials still believe that it is important to get the data on a high-speed maneuverable re-entry vehicle, but the budget shortages will not allow an early start.

• **"Can" history**—The Air Force recommended a *Gemini*-plus-"can" approach a year and a half ago after looking over various other approaches, including extending *Apollo*. The approach as outlined in the DOD *MOL* release is very similar, though no one knows at this point whether it is, or will be, the same thing exactly as recommended earlier.

There were other AF proposals for manned satellites, but this *Gemini*-plus-can proposal was presented more in depth than others because it appeared to offer the greatest promise.

The AF recommendation called for a can about 10 ft. in diameter and 20 ft. long capable of holding a crew of two to four men. The outside configuration would remain unchanged, but it would differ internally depending upon the number of crew members and the experiments to be conducted.

Based on the *Titan III's* payload capability of 25,000 lbs. and the *Gemini* weight of about 7,500 lbs., approximately 18,000 lbs. would be available for the can, its instrumentation and the adapters that are needed.

The plan called for no artificial gravity because it is estimated that it would add $100 million to the cost and complicate docking and transfer problems. There is a slim chance that an internal centrifuge couch for crew conditioning may be included in the design.

The Air Force also reportedly wants to make use of NASA's studies of the *Manned Orbiting Research Laboratory* (*MORL*) and North American Aviation, Inc.'s study of the extended *Apollo* spacecraft.

• **Just ahead**—The next step in the program now is parametric studies and tradeoffs. No decision has been made as to whether a special project office will be set up to run the project and handle such pre-program determinations as what kinds of experiments should be included, and what activities are needed to define man's military utility in space.

The contract for the *MOL* can will be competitive. Two major awards are possible—one for design of the lab and another for integration/interface work.

An AF spokesman noted that man's utility in space can be categorized perhaps in three ways: 1) man as a part of an operational system, how he best fits, etc., 2) man as a tool to conduct experiments, testing, designing, development in lab; 3) man for performing repairs.

The answer to the first two requirements is of major importance. The first involves man in reconnaissance, surveillance, offense, and defense. The second involves finding out whether it is a better payoff to have a manned research and test laboratory even though developing unmanned systems. ■

NASA budgets may suffer . . .

Congress Initially Favorable To Air Force Management of MOL

by Heather M. David

CONGRESS GENERALLY is accepting the Defense Dept. announcement that the Air Force will build a *Manned Orbital Laboratory* as meaning that the military is getting a major space mission, and most members have indicated fiscal support.

However, the whole concept will get a major review before DOD can obligate any large amount of funds, because of a clause written in the 1964 appropriations bill. This clause, which was applied to the $125 million in *Dyna-Soar* money, stated clearly that this money was to be used for *Dyna-Soar* or Mach 3 aircraft. A DOD request to extend this to "other space vehicles" was specifically denied. Thus DOD must go before at least the Appropriations Committees, and perhaps even the Armed Services Committees, for permission to transfer the estimated $45 million remaining in FY '64 funds to the *MOL*.

Several Senators are expected to use this opportunity to question closely the wisdom of cancelling the *Dyna-Soar* project and to voice their suspicions that this new project is just a sop to sweeten the real blow. Sen. Strom Thurmond (D-S.C.), a member of the Armed Services Committee, strongly protested the cancellation of the winged orbital vehicle, saying "the 1968 space laboratory announcement will not fill the void left by *Dyna-Soar's* death."

Thurmond indicated the fact that the laboratory has no specific objectives as proof that it is a project that DOD could drop anytime. "It should now be obvious that the whole approach to military research for strategic weapons systems is hobbled by the false premise that the nuclear-tipped ballistic missile is the ultimate weapon."

However, Sen. Daniel K. Inouye (D-Hawaii) another Armed Services member, said "it's obvious the Air Force has a place in space," and that he supported the *MOL* project.

Other members of both houses greeted the announcement with favor. Rep. Melvin Price (D-Ill.), Chairman of the House Armed Services R&D subcommittee which will authorize the *MOL* program, told M/R that he felt the new program would be an important one and that it would have many technical advantages. "*Dyna-Soar* had limited benefits," he said, "and we would not learn anything about maneuverability in orbit." He added that his subcommittee expected to carefully review the new program, along with other R&D programs, next year.

Space-minded Republicans, who strongly attacked the NASA space program as having no military value, cautiously endorsed the new move. Reps. James D. Weaver (R-Pa.) and Donald Rumsfeld (R-Ill.), members of a minority "Space Task Force," both expressed some disappointment over the cancellation of the *Dyna-Soar*, but applauded the awarding of an orbital laboratory to the Air Force.

Concern about a gap in knowledge about winged re-entry also was expressed by House Science and Astronautics Committee Chairman George P. Miller (D-Calif.), who said that this is a logical step which must be covered. However, Miller said "*Dyna-Soar* was a good project, since it gave us many breakthroughs in materials and other techniques, but it is not really practical since it could only go up and come right down. Sometime in the future we will have to go to a modified re-entry vehicle."

Miller added that his committee would look closely for cooperation between NASA and the Air Force, but that he felt that the fact that the Air Force now has its own project would make cooperation easier and rule out duplication. Both Miller and Manned Spaceflight Subcommittee Chairman Olin Teague (D-Tex.) voiced strong support for the military space program.

- **Effect on NASA budget**—The prospect that this is the beginning of another increasingly large space budget casts some shadow on NASA's budgetary future.

Much of the debate in both Houses during the NASA authorization and appropriation bills hit upon the security aspects of space and the necessity for maintaining superiority in this field. Many of those who supported the NASA program for this reason can be expected to shift their support to DOD.

Some observers have predicted a stretchout of several years in the *Apollo* program because of the new development. Teague said he did not see any drastic change "although an increased military space budget will cause some difficulties in getting NASA's budget through."

- **Disbelief in savings**—Defense Secretary Robert S. McNamara's statement that the new project will result in a $100-million savings over the next 18 months is not comforting to many Congressmen. Rep. James E. Fulton (R-Pa.) termed this "false ecomony" and urged reinstatement of *Dyna-Soar*.

House Defense Appropriations Subcommittee members Rep. Gerald Ford (R-Mich.) and George Mahon (D-Tex.) also expressed doubt about the savings which could be incurred in dropping *Dyna-Soar* and starting the new program. They indicated the subject would get a thorough going-over next year.

Other Congressmen indicated that although there might be some savings in the next 18 months, the program probably would end up with a rather high pricetag. ■

LBJ Due to Okay $5.1 Billion for NASA

PRESIDENT JOHNSON is expected to sign the Independent Offices Appropriations bill, including the $5.1-billion NASA FY 1964 budget, which was passed by the House and the Senate last week.

House conferees retreated slightly on the flat ban which the House imposed upon any joint Moon venture with the Russians, and accepted instead the Senate language which requires the approval of Congress for any joint Moon venture with any nation.

Since both Houses voted the same amount of money, $5.1 billion, no conference was held upon the amount.

Apollo Tracking Ship Accord Reached

by Hal Taylor

NASA and the Defense Dept. have signed an agreement which settles their long-standing dispute over the operation and construction of tracking ships for Project *Apollo.*

The pact—initialed on Nov. 22 by Dr. Harold Brown, Director of Defense Research and Engineering, and Dr. Robert C. Seamans, Jr., space agency associate administrator, is a compromise between the previous positions of the two agencies, MISSILES AND ROCKETS has learned.

While laying down general guidelines for the manned lunar landing tracking ship program, the agreement leaves unanswered an important question—how many ships are needed? This will be determined by Jan. 15 by a six-man committee composed of three representatives from each agency. The committee will decide not only how many ships are needed, but how many brand-new ships are required and how many current tracking ships can be modified.

The bi-agency agreement was ordered by the House and Senate space committees when NASA and DOD officials differed over who should direct the *Apollo* tracking ship program.

NASA wanted to build three new ships and have complete responsibility for their instrumentation and operation. DOD declared through Air Force officials that it should have responsibility for the program and that no new ships were needed. It maintained that current tracking ships could be modified for the job.

- **Assignments**—The new pact splits the differences between the agencies right down the middle.

It states that:

—NASA has agreed to let DOD maintain, schedule and operate the ships and the instrumentation on board the ships as part of its missile range tracking system. The Pentagon, in turn, has turned over this responsibility to the Navy Department's Military Sea Transportation Service.

—DOD has agreed to let NASA determine what the mission requirements or the ships are, as well as what instrumentation capability is needed.

—NASA also is responsible for determining when and where the ships will be stationed.

—NASA also will be charged with the integration of the ships with its ground tracking network for Project *Apollo.*

MSTS, in addition to operating the ships, will be responsible for their modification.

NASA's Goddard Space Flight Center will procure all instrumentation and equipment peculiar to Project *Apollo.* This will be then supplied to MSTS as Government-furnished equipment.

- **S-Band bids awaited**—In connection with its *Apollo* responsibilities, Goddard recently asked industry to submit bids by Jan. 3, 1964, on its "Unified S-Band" method for providing tracking and communications for Project *Apollo.*

The multimillion-dollar contract is expected to be awarded by April 1, 1964.

It is termed "unified" because of the system's ability to transmit and receive spacecraft-positioning information and voice and telemetry data simultaneously over one frequency. It does this through a method of frequency sharing by dividing it into a number of sub-carriers. When received on the ground, the sub-carriers are separated by a detection system for the desired result. This technique is similar to the current FM station broadcasting practice called "multiplexing," in which two signals are put on one carrier and two different broadcasts are received simultaneously in the home to produce a "stereo" effect.

Design of the Goddard unified S-band system reflects successful techniques developed by NASA's Jet Propulsion Laboratory for use in their deep space instrumentation facilities (DSIF). Manned lunar mission tracking and data acquisition requires a 250,000-mi. capability. Since JPL has successfully used similar equipment in its lunar and interplanetary programs, Goddard scientists decided to adopt the "unified" approach.

Weighing the economics of an extensive development program to extend the range of existing network equipments against costs for the S-band system, it was also determined that a more reliable system costing less in time and money could be achieved faster.

Some 55 firms were told at a bidders' conference of the firm requirements for two complete systems and three partial systems. Optional needs for future delivery include four to 10 additional complete systems, including package services to accomplish erection, installation, integration and check-out on a world-wide basis. ■

Temporary Hiring Ban on Apollo Work

NASA HAS SLAPPED a hiring ban on most of its major prime contractors in the Project *Apollo* program.

The ban will continue until at least the end of the year, as the space agency makes a reassessment of its manned space flight effort (M/R, Dec. 9, p.16).

The firms were informed by telegram that because the budget for Fiscal 1964 will be less than anticipated or previously planned, they were directed to freeze their employment levels and not replace personnel when vacancies occur.

The freeze is only temporary and is expected to be lifted as soon as the agency decides just what funds will be reprogrammed to make up for budget cuts which reduced funding from $5.35 billion to $5.1 billion.

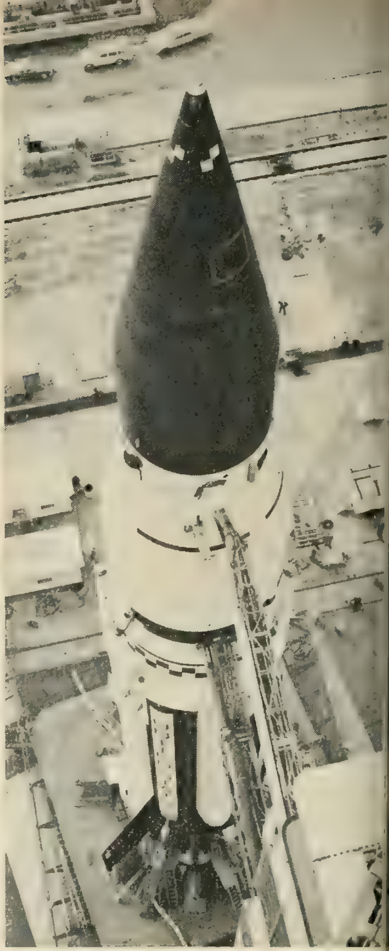
While the Administration permitted the telegrams to be sent, the White House did prevent NASA from issuing a press release. This apparently stemmed from Administration desire to prevent public reaction from affecting current discussions of a supplemental Fiscal '64 appropriation bill.

The telegrams were sent to the Chrysler Corp., the Boeing Co., North American Aviation, Inc., Douglas Aircraft Co., Inc., Massachusetts Institute of Technology, Kollsman Instrument Corp., AC Spark Plug Div. of General Motors Corp., Raytheon Co., Rocketdyne Div. of North American, and the GE *Apollo* Support Dept.

Set for Dec. 18 . . .

Space Leadership Hinges On SA-5 Shot Success

First two-stage test of vehicle would give NASA world's most powerful booster, put largest known payload in orbit



SATURN SA-5 rests on its launch pad at the John F. Kennedy Space Center.

THE U.S. THIS WEEK may take over world leadership in the development of large space boosters and the orbiting of heavy payloads.

This space age milestone hinges on the successful launch of the first two-stage *Saturn I* launch vehicle.

The *SA-5* flight—scheduled for no earlier than Dec. 18—will test for the first time the booster's S-I stage of 1.5 million lbs.' thrust and its liquid-hydrogen-powered second stage with a thrust of 90,000 lbs. Together, the two stages give the U.S. a launch vehicle far more powerful than any known Russian rocket.

The flight is also designed to put into orbit a 37,700-lb. payload, the world's heaviest to date. It will consist of the *Saturn's* empty S-IV stage, weighing 14,300 lbs., an instrument unit weighing 5,200 lbs., a 4,000-lb. payload adapter, a 2,500-lb. nosecone adapter and 11,700 lbs. of sand ballast. The payload contains no scientific experiments, but it does carry instrumentation which will be used to confirm that it is in orbit.

- **Anticipated orbit**—Planned orbital parameters are a perigee of 160 miles and a 400-mi. apogee. The orbital lifetime is estimated at from several days to several weeks.

Prime objective for the flight is not the orbiting of the payload, but rather proof of the successful development of the *Saturn* booster. *SA-5* is the fifth flight in the *Saturn* series. The four previous vehicles, all launched successfully, were known as Block I vehicles because only the first stage engines were actually ignited.

SA-5, with its live second stage, is the first of the Block II vehicles. With a payload capability of 20,000 lbs., later *Saturn I* launches will be used to boost unmanned models of the *Apollo* spacecraft's command and service modules. The eighth and ninth launches will also carry a large meteoroid detection satellite with a wingspan of 100 ft.

The *SA-5* vehicle is 164 ft. tall and weighs 1,121,680 lbs. at liftoff. It consists of four elements: S-I stage, S-IV stage, instrument unit and payload assembly (including adapters).

- **First stage altered**—In addition to the first test of the S-IV stage, the S-I first stage has also been modified and is undergoing its first flight test in its new configuration. S-I changes include:

—The eight H-1 engines for the first time will provide full rated thrust of 188,000 lbs. each, giving the stage the designed thrust of 1.5 million lbs.

—The nine propellant tanks have been extended by 6 ft., adding about 100,000 lbs. to the usable propellant capacity (850,000 lbs. presently) and 30 seconds to burning time.

—Tail fins have been added for increased stability.

SA-5 will be fired on a 90-degree azimuth, but during the first few seconds will "roll into" the flight azimuth of 105 degrees.

The tilt program will begin after 15 seconds of flight. The rocket will continue to tilt until the 135th second of flight, when it will be inclined at 63 degrees from the launch vertical.

- **Burning estimates**—According to propellant-utilization estimates, the S-I inboard engines will be cut off at T+141. The outboard engines will be cut off by an automatic timer (program device) six seconds later. At S-I cutoff, the vehicle will be traveling at 5,200 miles per hour, the altitude will be about 48 miles and the range about 65 miles.

Within less than two seconds, the S-IV's four solid-propellant ullage motors begin their 3- to 4-second firing periods. Separation command is given and the explosive bolts attaching the two stages are activated. Then the S-I's four solid-propellant retro-rockets begin their two-second firing period. The S-IV stage engines are then ignited, at about T+149.

Some 20 seconds after S-IV ignition, the stage's ullage rockets are jettisoned and the tilt program is resumed and lasts until cutoff, at which time the rocket's angle will be 107 degrees from the launch vertical. The S-IV burns to T+630 seconds, or almost eight minutes. At that time, 10½ minutes after liftoff, the upper half of the vehicle goes into orbit.

At insertion into orbit, the body will be traveling at approximately 16,650 miles per hour. Injection will occur about 1,300 statute miles downrange from the launch site, 375 miles north of Antigua tracking station of the Atlantic Missile Range. ∎

Arab orders reported . . .

German Firm Plans Missile Exports

by Frank G. McGuire

HAMBURG, WEST GERMANY—A firm based here says it expects to receive a license this week for exporting missiles, marking the first major entry of German industry into the missile market. There are reports that orders already have been placed, apparently by Middle-Eastern Arab nations.

Waffen und Luftrüstung e.V. (Weapons and Aviation Armaments Corp. [WAAC]) announced on Dec. 5 that it had signed a contract to deliver missiles to an unnamed foreign country. Earlier on the same day it test-fired four solid-fueled rockets—three single-stage and one two-stage—at Cuxhaven, a North Sea port near here, before an audience including military attaches from the Jordanian and Saudi Arabian embassies at Bonn. It said the rockets reached 90,000-ft. altitude and all shots were "completely successful."

In Bonn, the West German government promptly said "it is not contemplated to issue export licenses for this or any other firm to sell military rockets abroad." The statement was aimed at countering public censure. It was recalled that West Germany renounced manufacture, much less export, of military rockets except for small antiaircraft types when it was admitted to NATO in 1954 (see box).

On Dec. 9, however, a spokesman for the WAAC told MISSILES AND ROCKETS that Bonn government officials had visited them for two hours and that the firm expected to get a license for the work it had previously described. He refused comment on why the statement on denial of a license had been made.

A license will reportedly be granted by the Defense Ministry allowing military rocket development along with small, fast patrol craft being made by the same company. Surface-to-surface rockets are to be fired from this craft by an undisclosed customer.

- **Vehicles**—In the test firings at Cuxhaven, the quartet of rockets were launched out to sea from rails. All appeared to be antiaircraft types and the single-stage missile is apparently serving as the first stage of the two-stage version.

The single-stage vehicle is 9 ft. long and approximately 12-18 in. in diameter, according to the firm. The two-stage missile is 12 ft. long, has about the same diameter as the single-stage, and its first stage has a length of 9 ft.

Both missiles use radar guidance, but Richard Stengler, general manager of the company, declined to discuss the type of radar, the operating frequencies, or exactly who makes the equipment.

Both basic types of rocket demonstrated at Cuxhaven have small delta fins at the rear, and a similar set of fins are located at the rear of the second stage of the longer missile.

Ground range of the missiles is reported to be 50 miles for the single stage and 85 miles for the two-stage. Speed was claimed to be "well over Mach 3."

A surprising note was struck when Stengler said only eight complete vehicles have been test-fired. Four tests preceded the Cuxhaven firings, and it is apparently on the basis of these eight launches that orders may have been placed.

- **The company**—WAAC describes itself as a holding company with 160 affiliates who make all components for a line of missiles and already have orders exceeding their immediate production capacity.

Stengler said many details of the firm's products, and identities of its affiliates, are still secret, but he indicated that considerable German industrial effort is behind the move. Little corroboration for the company's statements is available from other sources because of the firm's secretiveness and its relatively short period of existence.

The exact nature and capabilities of Waffen und Luftrüstung are somewhat hazy. The German counterpart of AIA, Association of German Air and Space Industries, disclaimed any knowledge of the firm. Stengler, however, said that many companies now holding his firm's stock are members of the association.

President of the company is 25-year-old Joachim Boegner, an aeronautical engineer formerly in business for himself. General manager Stengler joined the firm from the German Air Ministry. Third member of the management team is Curt Wuthenow, an engineer.

Stengler told M/R that the firm is capitalized at over two million marks ($500,000) and insisted there is every reason to believe the application for export licenses will be granted, even though six different ministries have a hand in the matter.

"We are on favorable terms with most of them," he added, "but some of them do not like us as much as the others." He said the firm hopes eventually to sell its products directly to the German government.

- **Background**—An interesting history of Waffen und Luftrüstung e.V. was turned up by M/R, although no one connected with the company mentioned it, and the significance is uncertain. Stengler said the firm was founded nine months ago, and gave the impression that the affiliates had set the holding company up to act as a marketing outlet and a coordinating company for the various capabilities represented.

However, an organization called Bundesverband der Luftfahrzubehor- und Raketenindustrie e.V. (Association for the Manufacture of Parts for Aircraft and Missiles) was doing business at the same address, with the same telephone number, and with the same officials prior to nine months ago. This organization, like the present one, was an association, not a corporation. ■

Possible Pact Violation?

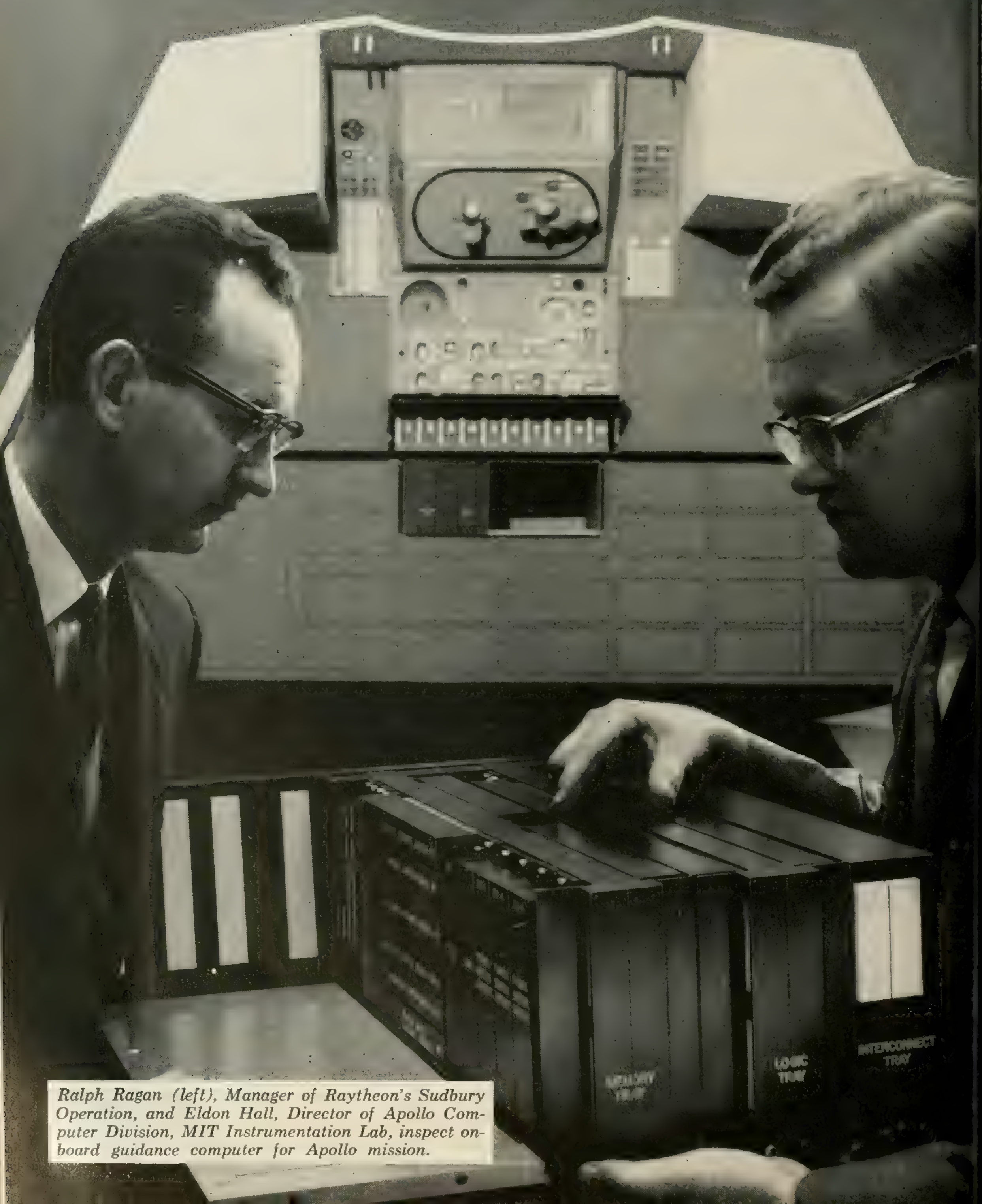
A TREATY signed in Paris on Oct. 23, 1954, admitting West Germany and Italy to NATO effective May 6, 1955, included a list of types of weapons whose manufacture was to be prohibited in West Germany. The list could be changed only if the change were suggested by NATO military leaders, formally proposed by the Bonn government, and then approved by a two-thirds majority of the Council of the Western European Union.

The proscribed list included long-range and guided missiles. It exempted "short-range guided missiles for antiaircraft defense" provided they did not exceed these characteristics: Length, 79 in.; Diameter, 11.6 in.; Speed, 1,470 mph; Ground Range, 19.8 mi.; Weight of Warhead, 49.5 lbs.

The WAAC missiles as described by the company apparently exceed all these limitations.

MIT/RAYTHEON STATUS REPORT:

APOLLO Guidance


MEMORY TRAY
LOGIC TRAY
INTERCONNECT TRAY

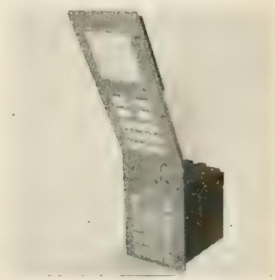
Ralph Ragan (left), Manager of Raytheon's Sudbury Operation, and Eldon Hall, Director of Apollo Computer Division, MIT Instrumentation Lab, inspect onboard guidance computer for Apollo mission.

Predicted Reliability Increased More Than 2:1 ...Contract On Schedule

By incorporating the latest rope memory module and integrated micrologic techniques into Apollo's on-board guidance computer, the MIT/RAYTHEON team has *doubled* predicted reliability of the system with no loss in scheduling time.

Drawing upon a background of successful joint effort in developing the reliable Mark 2 Polaris missile guidance computer, the MIT/RAYTHEON team is striving for similar fault-free operation of its Apollo guidance system. The operating computer, less than 1 cubic foot in size, will provide mid-course navigation and guidance data for NASA's Apollo spacecraft mission.

The MIT/RAYTHEON-developed computer contains an extremely dense, low-powered, fixed memory of 5,000 bits/cubic inch. In flight, the astronaut will operate the computer through a 16-button coded keyboard. In case of input error or an "unacceptable" order, a light will warn the astronaut to erase the error. When the command is correct, he pushes an "enter" button and the computer will take over, using inputs fed to it automatically from the other subsystems in the craft.



Keyboard for Apollo's on-board guidance computer.

The working relationship of the MIT/RAYTHEON team in developing and producing the computer, its displays and keyboard, and its pre-flight ground support equipment, represents a truly unique capability in space age guidance and control. *Space and Information Systems Division, Sudbury, Mass.*

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Research and develop equations and techniques for orbit and trajectory computations of earth satellites and space vehicles, satellite intercept and rendezvous, space surveillance; effects of drag and other non-gravitational forces; powered flights; range safety. Interactions of injection parameters, launch windows and orbital parameters. Digital and analog simulation programs. Tracking sensor deployment, statistical analyses, data filtering and error propagation; research celestial mechanics.

AERODYNAMICISTS

Original analytical work in the fields of re-entry physics, hypersonic gas dynamics, drag phenomena, aerodynamic coefficients, space flight under conditions of planetary atmospheres, orbital decay and re-entry predictions, atmospheric models, aerodynamic problems of missile and satellite decoy deployment, re-entry flights, stability of vehicles, dispersion studies, and determination of vehicle flight performance.

• SYSTEMS ANALYSIS

Systems analysis studies concerned with conceptual designs and effectiveness measures of counter measure and counter-counter measure systems in futuristic situations. Also studies in utilization of information from various types of tracking devices for purposes of orbit identification and improvements.

• ARMAMENT ENGINEERS

Engineering degree plus 3 to 5 years experience in aerospace industry armament. Experience related to high explosive or nuclear warhead design and development with allied experience in safety arming and fuzing systems is desired. Specific duties will include armament component development and system integration. Participation in preliminary design and conceptual studies related to the acquisition of new business.

• SOLID ROCKET PROPELLANT DEVELOPMENT

Engineering degree plus minimum of 5 years experience in solid rockets. Individuals experienced in establishing initial design configuration, integrating the equipment into aerospace systems and completing development and qualification are desired. Assignment will be in the Propulsion and Ordnance Systems Department, will be broad in scope and will include design, development, test coordination, technical direction of subcontractors and integration of the product into end item systems.

• ADVANCED PROPULSION SYSTEMS ENGINEERS

Parametric trade-off studies of competing propulsion systems and preliminary propulsion system design for advanced manned and unmanned space system studies.

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Technical Countdown

ELECTRONICS

STAR Phase-I Tests Successful

Bendix-Pacific Div. is negotiating a Phase II contract with the Air Force for development of prototype equipment for STAR, a Ship-Tended Acoustic Relay system. The missile-impact location technique ultimately will employ a single array (for a given impact area) of seven hydrophones symmetrically distributed over a 10-mi.-dia. circle. These will provide impact data by FM relay to more sophisticated receivers aboard a vessel at the array center. The cableless solid-state system has passed preliminary (Phase I) testing off the Bahamas, and Bendix claims it will meet demands for unattended operation up to one year at depths to 20,000 ft. Each hydrophone carries an expendable battery pack and can be recovered by surface command.

Radar Accuracy Formula Presented

A method for determining the degree of accuracy of manned spacecraft radar ranging in the presence of wavelength smears has been developed by Purdue University Professor George R. Cooper. In reporting an approach for using his formula before the International Scientific Radio Union last week, Cooper suggested that it could be used by designers of space vehicle radar systems. He also pointed out that by comparing the accuracy of a system already designed with the theoretical optimum obtainable through his new method, designers would know the extent of improvement possible to obtain by performing modifications.

NUDETS Reports Despite Destruction

Electromagnetic, optical and seismic sensors employed by NUDETS, the Nuclear Detonation Detection and Reporting System, will respond rapidly enough to provide complete blast data before detonation could destroy the system, the Air Force disclosed last week. It apparently is possible for a given sensor to be destroyed before reporting; an AF Electronics Systems Div. (ESD) spokesman said, however, that redundant sensors widely dispersed will still detect and report. Developed by the General Electric Co. for ESD, a prototype system employing four sensor sites and a single computer encircles Washington, D.C. The computer/sensor station is in Pennsylvania; unattended sites are in West Virginia, Virginia and Maryland.

Cryogenic Cooling System For Electronics

Aerojet-General Corp. is perfecting a system to cool electronic components in space through cryogenic means under a $66,000 contract from NASA's Ames Research Center. The device, which has a single moving part, will use superinsulation as a heat shield, making operation in the —440°F range possible. A vacuum pulled over the system's liquid coolant solidifies it at that mean temperature. The system is designed for a year's operation in space.

PROPULSION

Amcel Stops, Restarts Solid Rocket

A solid motor design capable of command stop-start and thrust modulation with only one moving part has been successfully operated through five complete cycles by Amcel Propulsion, division of Celanese Corp. Under the sponsorship of the Air Force's Rocket Propulsion Lab, Edwards AFB, Calif., the program demonstrated that solid motors could perform similarly to liquids in thrust termination, restart and throttling. Times between motor operation varied as long as several hours, simulating actions required in some space maneuvering trajectories. Air Force spokesmen say the demonstration opens the way to using simple, low-cost solid motors in applications now being handled by liquid engines.

Newport News To Build 260-in. Rocket Case

Two 260-in.-dia., 60-ft.-long, solid-rocket motor cases will be fabricated by the Newport News, Va., Shipbuilding and Drydock Co. for Thiokol Chemical Corp.'s Space Booster Plant. The huge cases will barged to the Thiokol plant in Georgia and used in the Air Force's Large Solid Rocket Demonstration program. The chambers will be made from the new maraging steels, eliminating costly heat-treating facilities since these alloys can be welded in the heat-treated state.

Kidde Develops Pershing Compressors

Two high-pressure air compressors and purification systems are in development at the Aerospace Division of Walter Kidde & Co., Inc., for the *Pershing* (XM14) missile system. One unit, powered by an integrally-mounted 208-volt, 400-cycle, 3-phase electric motor, is for use in behind-line checkout and does not accompany the weapon to the field launching site. A twin compressor with turbine drive is designed to be housed in the portable blockhouse aboard one of the tracked vehicles in each *Pershing* launching unit. Air supplied by the Kidde compressors has a wide application in checkout and maintenance of the weapon system's pumps, valves, filters, cylinder assemblies, degreasers, accumulators and pressure gages.

MATERIALS

Non-Vacuum EB Welding Studied

Hamilton Standard's high-energy density electron beam-welding machine will be used to make butt welds, lap welds and "T" welds on AISI low-alloy steel, TZM molybdenum and René 41 in an inert gas atmosphere. The United Aircraft Div. will study out-of-vacuum EB welding under Air Force Research and Technology Division sponsorship. The firm had been working in the area under company funds. Hamilton Standard engineers expect the technique, if feasible, to supplement, not replace, vacuum EB welding.

New Elastomeric Insulation Available

A rubber-based insulation material, said to be better than Buna rubber, is out of the development stage at Thiokol Chemical Corp.'s Panelyte Div. The material has better erosion resistance than Buna N rubber and superior low-temperature elongation characteristics. This will permit thinner and lighter insulation in large solid rocket motors. A new semi-cured elastomeric insulation also has been perfected, along with a new catalyst for the production of epoxy-glass laminates with a controlled heat distortion point. The Panelyte Grade 162 catalyst is intermediate in properties between NEMA grades G-10 and G-11, and the laminates are used primarily as printed circuit bases.

New ASW Trainer Improves Readiness of Canadian Fleet

Digital computer control introduces major cost savings; system can maneuver 32 synthetic targets over 500-sq.-mi. area

By Michael Getler

HALIFAX, NOVA SCOTIA—A digital-computer-controlled anti-submarine warfare trainer at the Royal Canadian Navy shore establishment here has sharply improved the ASW proficiency of operational crews deploying aboard fleet units.

For the Canadians, whose strategic mission is heavily oriented toward ASW, operational status of the trainer marks a significant advance in the overall state of the art. It also appears to hold the key to skirting the economic restraints that hobble virtually all training at sea.

Details of the system, which has been operating here for just over a year, were revealed for the first time recently by RCN officers and engineers from the Sperry Gyroscope Co. of Canada, Ltd., developers of the trainer.

Though designed primarily to train operations teams for RCN ships and helicopter and fixed-wing aircraft ASW forces, the system could also be used for early pre-sea-trial evaluation of new ASW tactics against missile-firing submarines, and can be programmed to allow for defense with new guided-missile ASW weapons systems now under development.

The trainer, Sperry engineers point out, makes possible exercises that include use of guided missiles, exercises that would be either impossible or at best, difficult and expensive, in at-sea training.

The Canadians say the system has now been thoroughly "shaken down," and that down-time has been lowered to about ½ day per month. The system is in use about 35 hours a week at a running cost estimated at $300-400 per hour over the projected life of the unit, several factors below the costs involved in moving ships and planes to sea for a short period.

RCN officers report that 23 minor modifications already have been made in the system as experience was gained. Others are planned, including addition of a simulated Navy Tactical Data System.

• **Trainer layout**—Essentially, the tactical trainer consists of a control room, where the war-gaming and synthetic targets are generated and controlled, and a series of four operations rooms, representing either four destroyers or three destroyers and one aircraft carrier. These operations rooms are configured exactly as the Combat Information Center (in U. S. Navy parlance) would be aboard ship and

ONE OF FOUR ship's operations rooms located in the operations trainer. Rooms are configured just as combat information center would be aboard ship.

RADAR REPORTING system is one of four "ships" located in operations center. The Sperry Gyroscope-developed trainer can be programmed for missiles being developed.

also house the same equipment (such as radar indicators and plotters) as is used aboard ship.

Previously, RCN crews were trained with British Navy analog-type ASW systems in England, where equipment and CIC area layout both differed from the actual RCN operation.

Total non-government furnished equipment system costs are estimated at $800,000.

The trainer operations rooms are manned either by teams from existing fleet squadrons or by new crews attending fleet schools.

Heart of the trainer is a solid-state "off-the-shelf" Packard-Bell 250 digital computer, which the Canadians claim probably marks the initial introduction of digital computer control to ASW trainers of this size. The relatively high speed of this device, together with its program flexibility, allows for a virtually continuous action plot of the exercises, in comparison with earlier systems in which there were obvious pauses between actions and reactions due to data processing limitations.

In addition to simulated radar, sonar, and wind inputs, the trainer is capable of generating up to 32 synthetic targets, including the four participating destroyers, 10 surface ships and submarines, 14 fixed-wing aircraft and four helicopters (see box). With the exception of the destroyers, under control of their own crews, the control room personnel can maneuver all other targets at will within the 500-mile-square playing area.

With this type of system, more than one problem, each perhaps involving a pair of destroyers, can be run simultaneously.

- **Noise and target modes**—The system is also designed to include radar jamming capability, other radar noise and sea clutter, programmed fade range of targets (the target disappears at a certain range rather than gradually fading), and target modes for surface or submarine craft indicating either submerged, on the surface, or at snorkel depth (the snorkel target is reportedly somewhat stronger than would be the case at sea).

In the control room, a large projected display shows all tracks and identifying symbols of targets operating within a selected 100-, 25-, or 12.5-mile-square area of the total 500-mile area. There are also two CRT displays, one of the entire 500-mile area showing and identifying all aircraft targets; another, used for close control of aircraft and helicopters, presents an expanded 25- or 12.5-mile sector.

The information available to control room personnel includes course, speed, and target mode of surface and subsurface ships; ground speed and altitude of aircraft; range and bearing of possible sonar contacts; and relative range and bearing between selected targets.

TARGET PERFORMANCE CHARACTERISTICS

a) DESTROYER ESCORTS:

Quantity: 4
Speed: 0 to 40 knots ±3%
Course: 0 to 360° ±1°
Turning Circle: approximately 400 yards at 30° of helm
Helm Angle: 0 to 35°
Acceleration/Deceleration: 4 knots per minute.

b) SURFACE/SUBMARINE TARGETS:

Quantity: 10
Speed: 0 to 40 knots ±3%
Course: 0 to 360° ±1°
Rate of turn: 0 to 3° per second.

c) HELICOPTER TARGETS:

Quantity: 4
Speed: 0 to 120 knots ±3%
Course: 0 to 360° ±1°
Rate of turn: 0 to 90° per second.

d) FIXED WING AIRCRAFT:

Quantity: 14
Speed: 0 to 1,200 knots ±3%
Course: 0 to 360° ±2°
Rate of turn: 3° to 9° per second.

e) POSITIONING ACCURACY:

All of the above targets may be positioned to the closest tenth of a mile in the 500-mile-square grid.

SIMULATED RADAR CHARACTERISTICS

Pulse length: 0.25 to 2.5 microseconds ±20%
Trigger amplitude: 5 to 50 volts positive into 75 ohms
P.R.F.: 100 to 1,000 pulses per second
Output video: 3 volts positive going into 75 ohms with a bandwidth of 3 megacycles per seond.
Antenna beamwidth: horizontally 2° wtih a gapless coverage in the vertical plane.
IFF beamwidth: 12°
Antenna rotation: 5 to 15 RPM
Minimum range: 50 yards
Jamming Characteristics: 2° sector noise jamming for each fixed wing air target, while noise and all around sea clutter of adjustable initial amplitude and rate of decay with range are also provided.
Radar range accuracy: ±49 yards
Radar azimuth accuracy: ±0.5°

SONAR CHARACTERISTICS

Range: 0 to 5,000 yards ±50 yards
Bearing accuracy: ±2.8°

WIND CHARACTERISTICS

Speed: 0 to 80 knots in 10 knot intervals
Direction: 0 to 360° in 10° intervals.

POWER REQUIREMENTS

115 volts 60 cycle single phase 100 amperes. 220 volts 60 cycle single phase at 50 amperes and 24 volts DC at 4 amperes.

OVERALL

The system contains approximately 40 consoles, racks and sundry pieces of equipment. The total volume is about 1,000 cubic feet and the weight is approximately 10,000 lbs.

SYSTEM PERFORMANCE

Data provided to the destroyer CIC's simulates that which would be available through the ship's sensors, such as radar information (with accompanying radar clutter and noise); course and speed data, fed to plotting tables and compass repeaters; and sonar range and bearing of targets. Communications are fed through simulated radio, broadcast, and command circuits.

Initial target data for the exercise are first generated by the control consoles and then entered into the computer, which is programmed to continuously calculate the bearing and distance of all 31 targets in sequence from each of the four destroyers.

The computer transmits this data once every three seconds to the output control unit, or data converter.

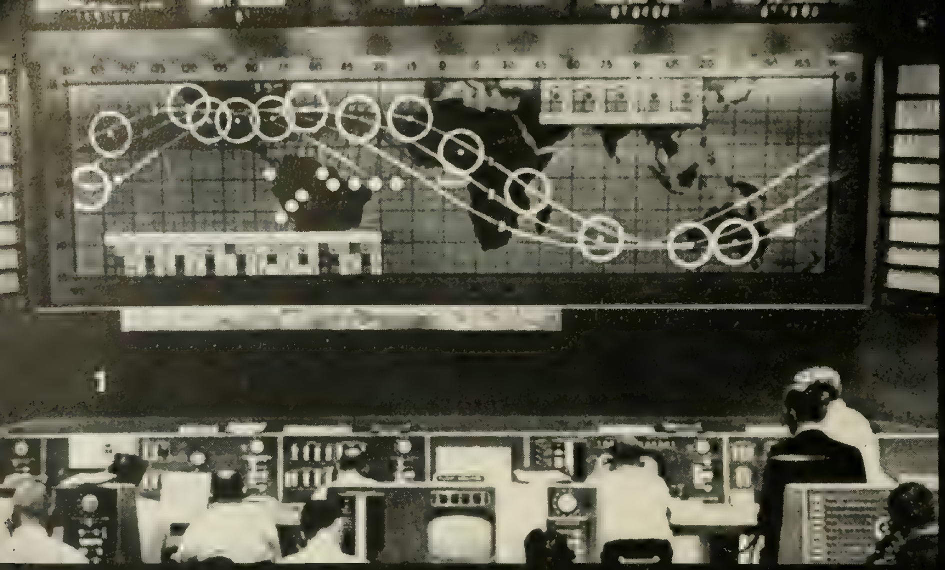
This output control unit actually consists of a radar logics unit, radar video unit, and sonar converter. The radar logics section contains digital circuitry to sort the calculated target data and initiate generation of radar and IFF signals. The video unit accepts this data and actually generates the required video and trigger signals. The sonar converter accepts parallel digital words (from the computer output buffer) that represent the range and bearing of four sonar targets relative to the associated destroyers.

The output from this device, based on the digital computations, is displayed on the respective radar scopes and plotting tables of the destroyers every three seconds. Reactions and new maneuvers from the various operations rooms are then relayed via the simulated command nets to the control room staff and consoles, with the resultant action by both destroyer staff and target controllers initiating new computer calculation.

The main control room display by which personnel view the exercise is provided by a Kelvin-Hughes Rapid Processing and Developer Projector. This unit, in effect, films the computer output, processes it, and displays it to the selected scale every 8 seconds, just about five seconds beyond the state of the action of the computer generated radar and sonar displays.

The value of the filmed exercise is doubled through post-action availability of the film, possibly combined with taped radio messages, as an important and economical debriefing tool.

Installation of a second system at the Canadians' West Coast facility in British Columbia is said to be under consideration. U.S. Navy officers have visited the RCN trainer and reportedly showed an interest in the system, but presently there are no plans for USN use. RCN officers point out that it is unlikely that duplicate hardware systems would be built by other navies, but rather that the systems concept, including digital computer control, might be applicable to other systems with special requirements. ■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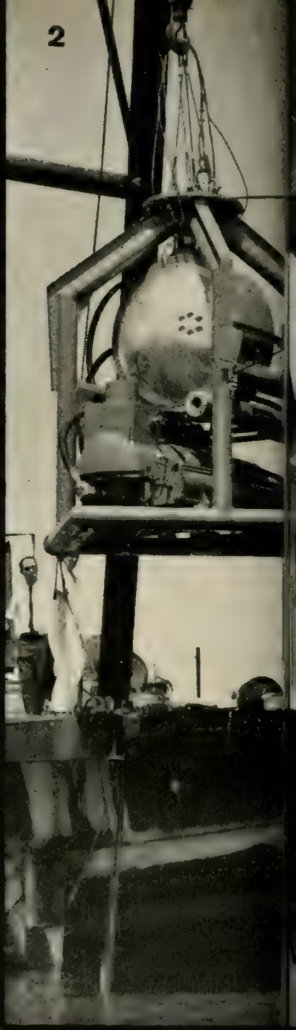
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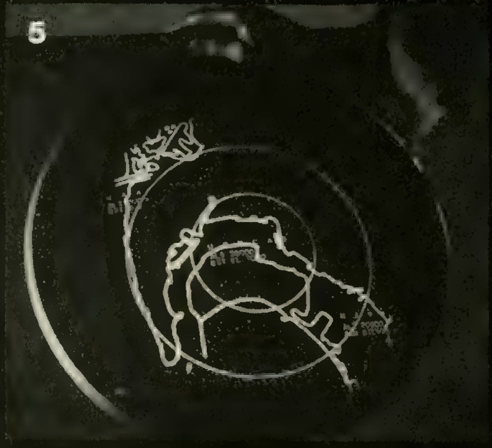
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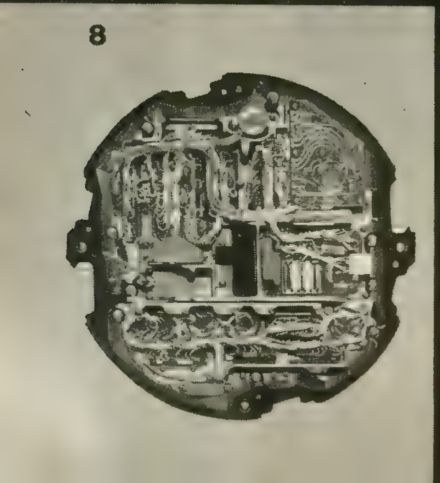
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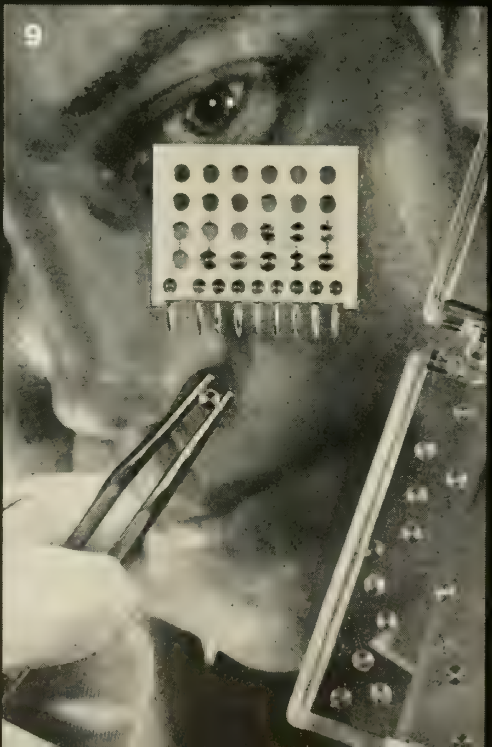
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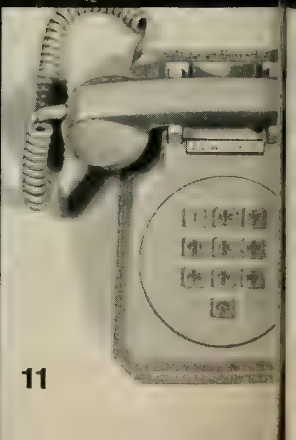
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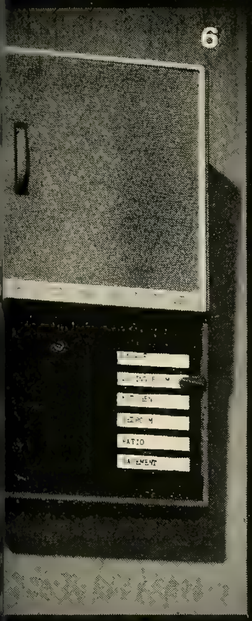
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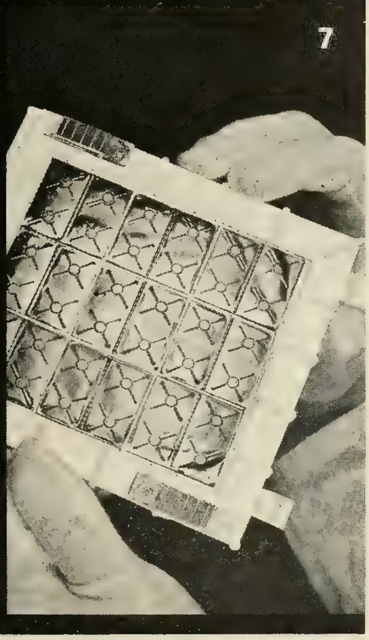
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12

1. Visual display system at Project Mercury Control Center simultaneously shows flight path, capsule environment, and physiological reactions of orbiting astronauts.

2. A six-ton acoustic transducer provides a massive source of underwater sound in anti-submarine warfare studies.

3. A high intensity laser beam cuts through a sheet of steel alloy.

4. One of several types of antennae of the Global Tracking Network (Glotrac) for precision tracking of space vehicles orbiting thousands of miles high.

5. Information from computers, radar and other communication links are displayed instantaneously to show an air traffic controller the identification, changing position, altitude and direction of aircraft in his vicinity.

6. The transistorized "Signette" offers economical, high quality intercom service in homes and small commercial operations.

7. Tiny thermoelectric elements sandwiched between thin metallic sheets convert solar energy into auxiliary power for space vehicles.

8. An electronic "wheel," interchangeable and easily replaceable, is one of several which make up the guidance system of an air defense missile.

9. Microminiature circuits are built up of semi-conductors in the form of tiny pellets interconnected simultaneously by conducting cement.

10. Ground hugging flights are made easier by a Terrain Following Radar system which helps guide an aircraft over unknown terrain in zero visibility.

11. The first commercial push-button telephone went into service in mid-1963.

12. A new jeep-carried single-sideband radio is half the size of the set it replaces, but provides ten times the effective signal power, and twice the range.

To show the whole range we'd need more than two hundred pictures

And each one, as do these twelve, would show a different kind of electronics research or production by General Dynamics. Of our thirteen operational units, nine are actively engaged in advanced phases of electronics, to make General Dynamics a key producer for defense, industry and space—and a major factor in keeping America strong.

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R&D Growth Altering U.S. Economy

Public accepts large expenditures for missile/space R&D; sees technological 'fallout,' more jobs and business as fringe results

by William Beller

(Last of a three-part series. Part II appeared Dec. 2; Part I, Oct. 28)

THE BIRTH and growth of the missile/space industry—nurtured by Federal funds and maturing in a short time span—constitutes a revolution in industrial progress.

Largely as a result of the industry's missions, the Federal Government today supports and directs nearly 70% of all research and development conducted in the U.S.

Federal R&D expenditures have jumped from $500 million in 1940 to $1.5 billion in 1950 to $15 billion in 1963. As a government spending program, science is now second only to military hardware procurement and Armed Forces personnel payrolls. It is greater than all agricultural subsidies combined.

Congress is only now trying to disentangle the threads of the Government's enormous skein of R&D. The reason the legislative body has waited so long "stems from the readiness of the public and the Congress generally to accept expenditures for national defense with comparatively little debate, convinced that they are probably essential to national survival," says John H. Rubel, former Assistant Secretary of Defense.

The public, moreover, has been told —and widely believes—that the money spent for military R&D and space will be transformed somehow by civilian industry into new products and conveniences, such as global television, near-perfect weather forecasting and sub-miniature radios.

In addition, the launching of *Sputnik I* in 1957 thrust the U.S. into a technological race with the Soviet Union that has one finish line on the Moon and others perhaps on Mars and Venus.

"Most important of all," says Rubel, "is the fact that about 66% of the funds spent for Federally supported R&D are expended by industry." Thus, the principles of private enterprise are not violated. Furthermore, the R&D usually financed by a firm's own capital now is greatly amplified and supported by the Government's. "This represents enormous business opportunities to firms furnishing R&D services and material to the Government," says Rubel.

- **Tooling up for R&D**—The missile/space industry, unlike any other major industrial field, is based on its ability to build on a fluid technology. For this reason, management must erect a structure of trained scientists and engineers, supported by computers as a service adjunct, test equipment and simulators as instruments of development, and perhaps a management system such as PERT to bind the seeming unknowns into a manageable package. Past performance in R&D increasingly is becoming the measure of a company's ability to produce, not the number of square feet of machine shop area or the number of sub-systems turned out last year.

Industry estimates that 18% of its top scientific and engineering talent is working on proposals rather than on project accomplishments. This is a figure put forth by Stanford Research Institute in a report prepared for the Aerospace Industries Association of America.

SRI observes that although about 75% of this effort is spent on unsuccessful proposals, based on current proposal acceptance experience, the effort is considered by many in both industry and Government to be worthwhile. "Each unsuccessful effort is said to ensure better understanding and capability for the next attempt," the report states.

- **Financial profile**—The SRI study shows that the median return on total assets for 19 "aerospace" companies, predominantly in the missile/space field, is below that for the general "cross-section" of U.S. manufacturing for each period except 1952-56. Briefly, for the 1957-61 period, the SRI report shows the median return on aggregated total assets for the 19 firms was 7.1%, compared with a median of 7.3% for a broad cross-section of 104 large manufacturing corporations.

SRI suggests, however, that return on net worth should be noted as a key ratio, if for no other reason than the weight it has received in renegotiation proceedings. Briefly summarized, the median return on net worth earned by the 19 aerospace companies in the 1957-61 period was 11.3%, compared with a median for the cross-section group of 9.8%.

The relatively more favorable return on aerospace net worth, as opposed to total assets, is said to be due to the greater leverage, and consequently greater risk, in the aerospace industry that results from the ratio of net worth to totally owned assets being substantially lower than for the cross-section of general manufacturing.

(*Total assets* is defined as the total of the asset side of the balance sheet: property (fixed assets) is included on a net basis after deduction of accrued depreciation and amortization reserves, and inventories are on a net basis after deduction of progress and advance payments. *Net worth* is defined as the sum of the par value of preferred stock, the capital stock account, capital and earned surplus and surplus reserves.)

As might be expected in an industry that is shifting from quantity production to limited, quality production accompanied by a tremendous emphasis on R&D, floorspace utilization is also markedly shifting. In 1961, based on information 28 companies reported to SRI, only seven companies were using more than 50% of floorspace for manufacturing. On the other hand, 14 reported utilizing more than 25% of their space for laboratories and offices, a doubling of those so disposed since 1955.

- **Small business picture**—Despite the missile/space industry's success in solving technical problems, a cry of anguish is heard from the small business sector of the field. The complexity of new systems and the accent on R&D is a burden new to these companies and one they find difficult becoming used to.

"There's not a Congressman alive who's not for motherhood, against sin and for small business—and sincerely," Irving Maness, Deputy Administrator, Small Business Administration, told MISSILES AND ROCKETS. The basic problem, though, is that small businesses usually don't have the money needed to develop the advanced art required for missile/space projects. If they get the art, it changes so rapidly more money is needed just to keep it current.

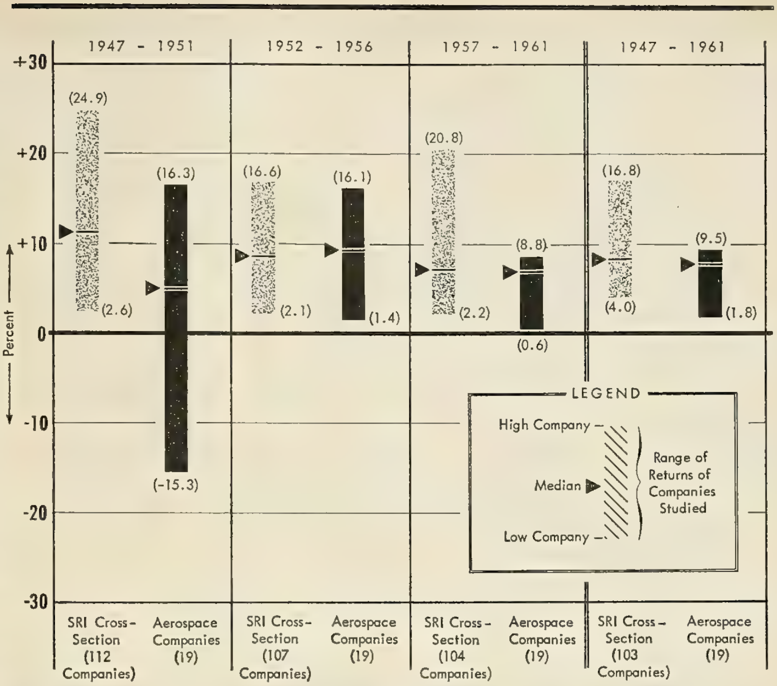
One of the nation's largest electronics firms, for instance, estimates that microelectronics, a field the company is only now entering with a major effort, will within 10 years affect 25% of the company's sales. This change undoubtedly will have a profound effect on many of the company's subcontractors, generating some new ones and, perhaps, driving the less aggressive into the television repair business.

Still the large missile/space companies—for their self-interests and for the well-being of the country—have a policy, abetted by SBA regulations, of helping small business. The reason is clear. About 70% of the procurement money spent by the Department of Defense goes to 100 companies, all in the big business category. Fifteen percent goes to many less large companies, and the remaining 15% to small businesses.

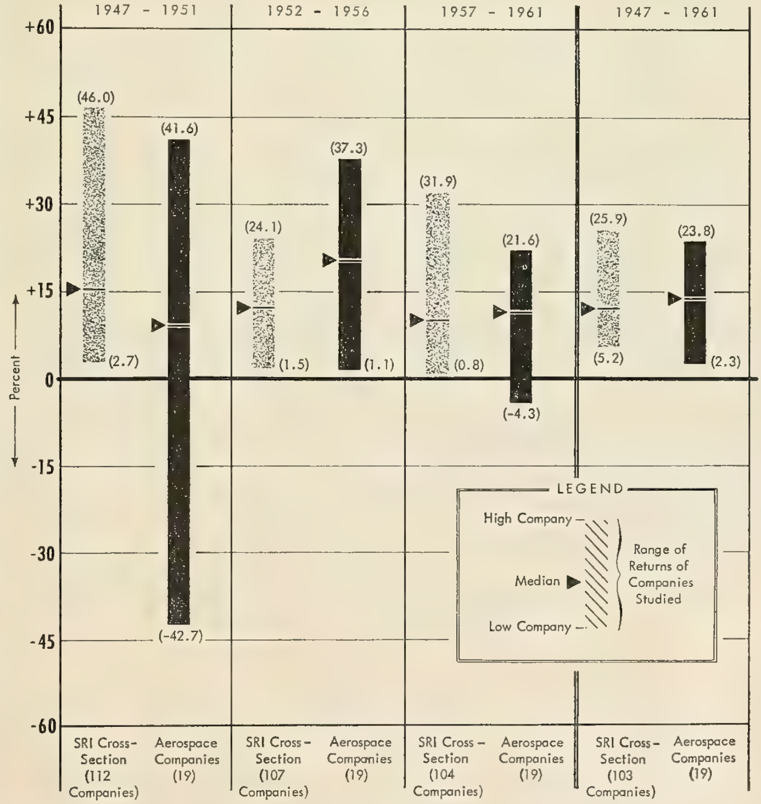
Maness points out that if the small business portion were lost, then soon the next 15% might go; eventually, by capillary action, the smaller of the 100 top companies would be reached until, conceivably a monopolistic condition might be reached. This would mean almost no competition for contract awards, fewer original and creative ideas and higher in-breeding, with the resulting weaknesses in systems, and poorer products for the taxpayer and the country's defense.

- **A shrinking percentage**—In the middle 1950's, companies that had been largely in the airframe business saw the spectacular growth of Federal funds for R&D and reacted logically. They went into electronics and sophisticated systems work as fast as possible, by 1) absorbing small "exotic" firms and 2) building their own operations in the newer fields.

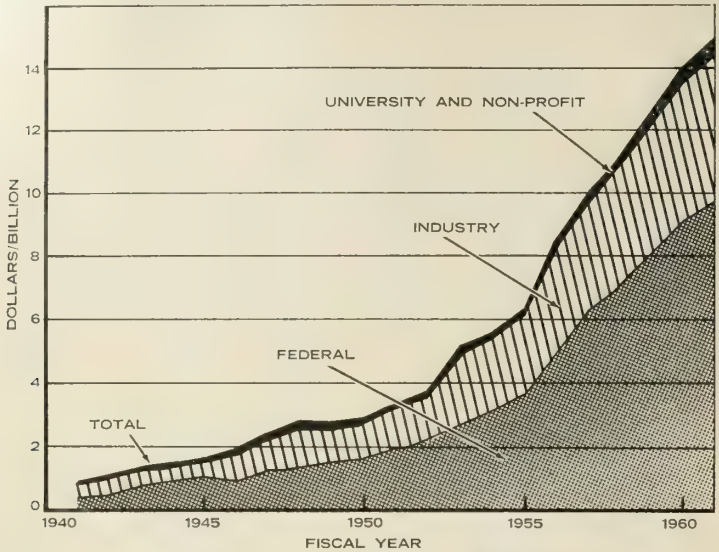
One result was to shrink the market available to small businesses. Statistics pointed up the problem, which grew worse from Fiscal 1954 to 1961. In 1954, for example, 25.4% of the defense money spent by prime contractors went to small business. By 1960, it had fallen to 16.1%; by 1961, 15.9%. One relieving factor was that at the same time the number of defense dol-



RETURN ON total assets, 19 aerospace companies and SRI cross-section of U.S. manufacturing



RETURN ON net worth, 19 aerospace companies and SRI cross-section of U.S. manufacturing



Growth of R&D Funds, 1941-1961

lars were increasing. But the squeeze on small business was evident.

Seeing what was happening, President Kennedy in 1962 issued a directive calling for a minimum of a 10% increase in the amount of business going to small business. The base used was 1960 and the required figure of 17.7% was reached for Fiscal 1962. In 1963, however, the figure dropped back to 16.5%.

Seemingly valid reasons were given for the fall-off: 1) more engineering than manufacturing was called for and most small businesses are concentrated in the manufacturing field; 2) products that did call for fabrication were highly sophisticated, not easily built by any but the most modern small businesses; 3) in addition to being intricate, the hardware often was physically large, calling for equipment not common to small business.

The Defense Department and NASA are nevertheless striving to give more work to small businesses, particularly by identifying standard items of procurement as early as possible and putting them out on a price-competitive basis.

- **Help from big business**—One of the pioneers in the use of small businesses in its projects, North American Aviation, Inc., in 1962 tapped the skills and products of some 12,000 little companies. "North American needs small business," says Rulon Nagely, company vice president. "We do business with them because it helps us to stay competitive."

On the other hand, a small business man landing a contract with North American is given an opportunity to keep up with advanced engineering design and production technology. This is a fringe benefit increasingly being offered by missile/space firms. Company-sponsored symposiums for small businesses to discuss programs and products is one kind of aid. In another assistance plan, North American, prior to signing a contract with a small business, may perform a quality control survey, offering its own experience in the increasingly demanding field as a guideline to new contractors. During production, participating companies may be given additional information and assistance.

This help not only keeps small business up to date, but also opens doors for sales of products and services to other companies.

Small business also has the advantage of being agile. "We can talk with North American engineers in the morning and start making parts in the afternoon of the same day," says Bill Arrasmith, president of Radar Relay, a company furnishing electronic equipment to North American. "We've got low overhead; we can quote low prices. We can move faster." He tells of a major program for which a switch was designed on a Saturday afternoon and a prototype was ready a week later. "As a result, we received a substantial volume of business."

Small business is also taking heart from the Defense Dept.'s call for "old-fashioned engineering," particularly for devising systems that might be needed in a limited war. Simplicity and ruggedness are bywords of Eugene G. Fubini, Assistant Secretary of Defense.

Fubini recently observed that during the early Antarctic expeditions, the tractor parties found they could get cheap and reliable antennas just by dragging wire on the ice. "There are people who believe that the Arctic ice, the salt water underneath and the air above make an ideal low-frequency wave guide," he added. "We ought to try to cooperate with the environment more when we design weapons and equipment and try not to fight the inevitable quite so much." This is one of the many challenges that can be met by small companies, especially those with a high Ph.D-count.

- **An Aladdin's lamp**—The missile/space industry has started a revolution comparable to the Industrial Revolution in its impact on society. It has developed not only the technology, but also the management skills for massive projects of wide social significance.

Beyond this, the activity, because of its large size, has even introduced broad social considerations into contract awards in terms of small business considerations and the labor surplus area program.

What the missile/space profile will look like 10 years from now is as difficult to answer as what the country's major space project will be 10 years hence. What can be said, though, is that the genie called forth by rubbing the missile/space lamp is too obstreperous for anybody ever to try to shove back into his container and too powerful not to be used as one of the major resources of the United States. ■

FLOOR SPACE ALLOCATION IN SELECTED AEROSPACE ACTIVITIES 1947, 1955, and 1961

	1947	1955	1961
Total floor space in activities surveyed (millions of square feet)	24.4	92.1	129.9
Total floor space utilized (millions of square feet)	23.5	90.1	125.3
Manufacturing floor space as percent of total utilized floor space	53.5%	51.7%	39.9%
Laboratory and office floor space as percent of total utilized floor space	21.1%	17.9%	28.4%
Storage floor space as percent of total utilized floor space	13.2%	14.6%	14.4%
Other uses as percent of total floor space used	12.2%	15.8%	18.3%

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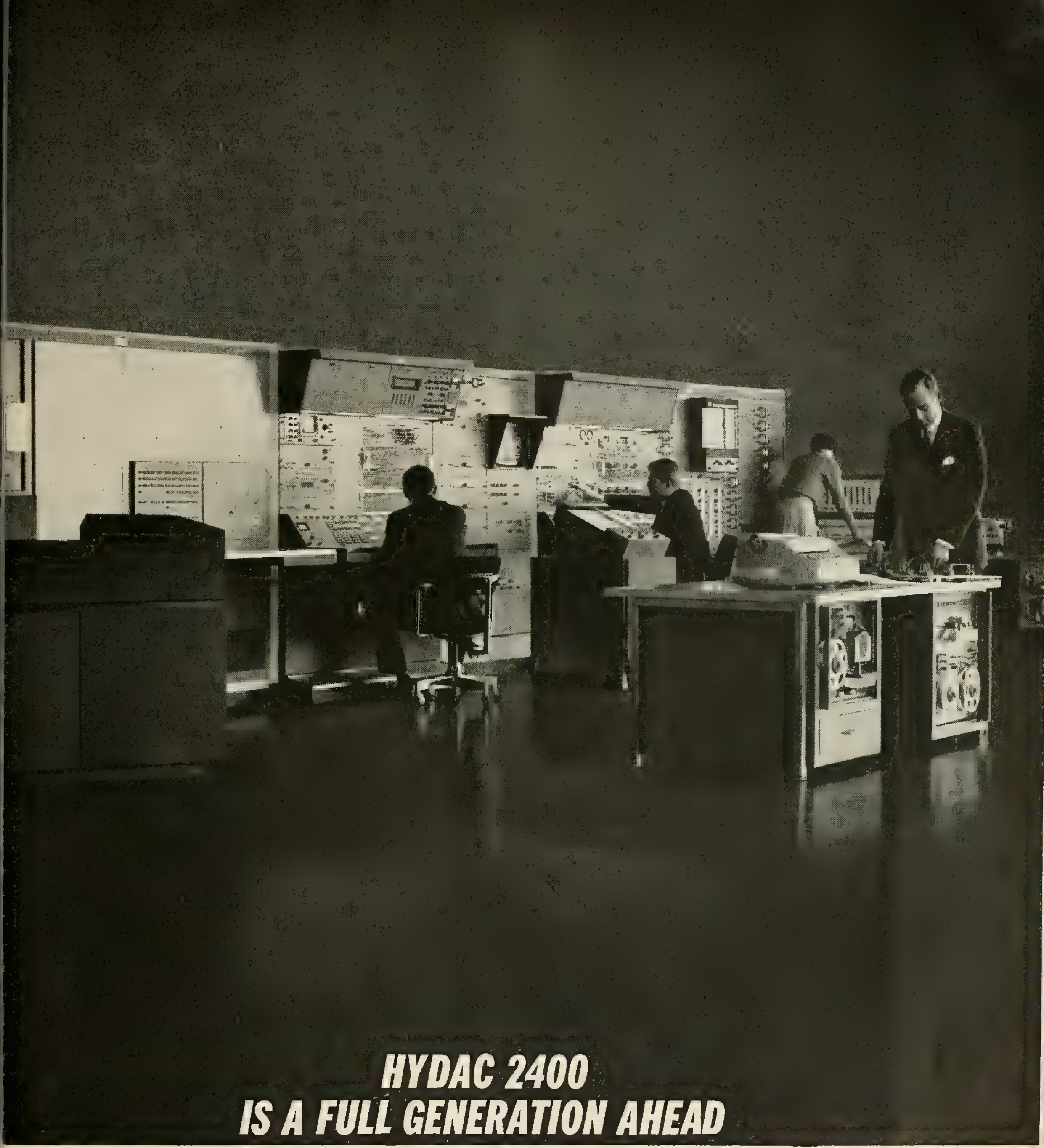

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Reliable Exploding Bridgewire Remains To Be Developed

Device would have significant advantages, including increased safety, over present methods for triggering relatively insensitive explosives

by Vincent J. Menichelli
U.S. Naval Ordnance Laboratory
White Oak, Silver Spring, Md.

A RELIABLE EXPLODING bridgewire system—an ordnance device used for mechanical actuation operations such as stage separation—has not yet been demonstrated.

Such exploding bridgewire (EBW) systems have distinct inherent advantages over the more common hot and explosive wire initiating devices. These include elimination of sensitive primary explosives, simplification or complete elimination of safety and arming devices with mechanical interrupters and the reduction of electromagnetic radiation effects.

These benefits have not been realized.

The major fault lies in current evaluation procedures—the emphasis is placed on the EBW device itself instead of on the entire system.

Exploding wires have been used for many years as light sources and in the production of shock waves and high-temperature plasmas. Recently, the principal interest has been in the use of exploding bridgewires for the direct initiation of relatively insensitive explosives.

This application is of prime importance in both weapons systems and space programs.

The ability to directly initiate high explosives by an exploding wire is particularly significant. EBW devices could eliminate very sensitive primary explosives, which in turn have required safety and arming devices (S&A) with mechanical interruptors.

Such devices are complicated mechanisms, which although necessary for safety, introduce a degree of unreliability to a weapon system. The weapon designer can immediately recognize the desirability of eliminating the S&A containing conventional electro-explosive devices (EED) by substituting an EBW in-line explosive train.

• **Electromagnetic hazards**—Another factor of increasing importance is electromagnetic radiation and the problems associated with it. The Department of Defense has an extensive study underway called RADHAZ (Radiation Hazards). A subprogram in the Navy study is HERO (Hazards of Electromagnetic Radiation to Ordnance).

It has been deduced from accidents and demonstrated by controlled experiments that present day electronic equipment can radiate electromagnetic fields of sufficient strength to initiate many conventional EEDs. A very insensitive device like an EBW could be used to overcome this problem. However, caution must again be exercised and a close inspection must be made of the EBW system, including the power supply and triggering mechanism rather than just the EBW alone.

The construction of EBW devices has been compared with the simplicity of construction and design of the more familiar wire bridge electro-explosive devices. A fine wire is attached to an initiator plug and explosive loaded on or near the wire.

A large amount of background data on conventional EEDs shows that a reliability of 99% or better at 95% confidence can be achieved. It is sometimes inferred that this degree of reliability can be extended to the EBW area. EBW construction and design probably are not as simple as conventional EEDs, and without quality controls more rigid than those for conventional EEDs, EBWs will not be as reliable.

• **What is it?**—Even the definition of an EBW is not universally accepted, but for this article we will define it as follows: An exploding wire is one that produces a supersonic shock wave in the containing medium. On the assumption that enough energy is applied to vaporize the wire and that the rate of energy input is very high, the following events occur:

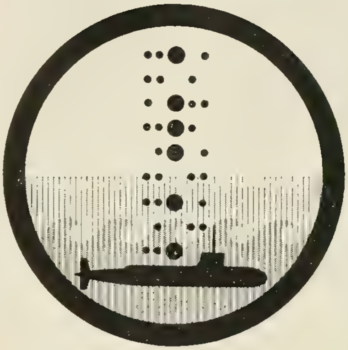
1) The wire superheats to a very high temperature; 2) a strong magnetic field about the wire resulting from the current in the wire tends to pinch it; 3) energy continues to flow into the wire which undergoes a transplosion to form an aerosol and/or plasma; and 4) a shock wave is formed by the rapidly expanding, high-temperature aerosol and/or plasma.

The differences in the EBW firing circuitry (including the EBW) are the key to the differences observed. Thus the bridgewire is an integral part of the firing circuit. Therefore, when characterizing an EBW device, firing circuit parameters must be well defined. In the application of an EBW device, the whole system must be considered—the EBW device transmission line, connectors, and firing circuit—and not merely the EBW device alone.

• **Design problems**—Development of reliable EBW devices requires an understanding of the exploding wire phenomenon and the parameters associated with the design and fabrication of EBW systems. The more significant parameters can be divided into two categories: electrical or circuit components, and explosive hardware and explosive characteristics.

The circuit components consist of: 1) power supply; 2) transmission line; 3) bridgewire; and 4) connectors. The explosive hardware and explosive characteristics include: 1) explosive material; 2) loading density of explosive;

multiple-target weapon control



General Precision System directs SUBROC missile

Underwater Fire Control System (UFCS) Mk 113 — which can track and zero in on several conventional or deep-running nuclear submarines simultaneously — directs the firing of the U.S. Navy's SUBROC missile. ☐ Built by General Precision, Inc., submarine-installed UFCS Mk 113 is the first antisubmarine warfare (ASW) weapon-control system with multiple-target capability. The system directs the long-range SUBROC weapon through underwater launching, atmospheric boost-glide trajectory, water re-entry, and target destruct. ☐ SUBROC was developed for the Bureau of Naval Weapons with technical direction by the Naval Ordnance Laboratory, White Oaks, Md. Librascope Division of General Precision's Information Systems Group produced UFCS Mk 113. ☐ Write for latest ASW information now.

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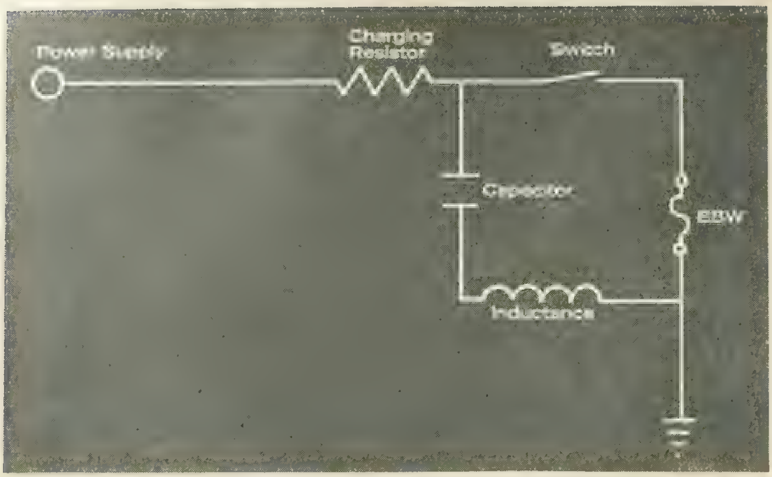


Fundamental Firing Circuit for EBW

3) dimensional tolerances of hardware; and 4) confinement.

In designing an EBW device, the explosive component must be considered together with the source that will initiate it. The electrical characteristics of the power supply will greatly influence the length, diameter and material required for the bridgewire and vice versa.

Almost all power supplies are now using a 1.0-microfarad capacitor charged to 2,000 volts. This combination may or may not be optimum. But as these components increase in size and circuit values, other electrical and physical problems may be introduced.

The higher potential and capacitance a power supply can be designed for, conceivably the more insensitive an explosive can be initiated. When the EBW power supplies are used in weapons systems, miniaturization is important because of weight and space considerations.

- **Package position**—The location of the power supply with respect to the EBW is also critical. Line losses can be high and pulse shapes may change drastically with increasing cable length. In addition, the connectors that unite the transmission line with the EBW and power supply should be carefully chosen.

The inductance and resistance to the entire EBW system should be as low as possible. Experiments have shown that low-inductance, low-resistance circuits will reduce or eliminate current dwells that adversely affect initiation.

A current dwell is a condition in which the electrical current in an exploding wire is rapidly reduced to nearly zero, remains at the value for a fraction of a microsecond to many microseconds, and then increases in a manner typical of a gaseous discharge.

Hermetic sealing of the EBW system is advisable for several reasons. Foremost is the surveillance advantage to be gained. The electrical and explosive characteristics of the EBW probably are determined at ambient pressures. When consideration is given to the environment in which the EBW will be initiated, it is quite possible that these characteristics will change under conditions of high pressure or vacuum. Hermetic sealing of the EBW will minimize these problems.

The bridgewire itself should be resistant to corrosion and have good mechanical strength. Popular materials are gold, platinum, and recently various noble alloys. The construction of the bridgewire circuit on the initiator plug can be flush (i.e. the entire length supported) or it can be extended, (i.e. the posts to which the wire is attached extended beyond the surface of the plug). Other constructions have been investigated, such as curved and stepped surfaces, which were intended to focus and enhance the shock from the bridgewire.

Comparison of flush bridges versus extended bridges have shown that flush bridges have lower threshold voltage requirements. Flush bridges are also recommended because the density of the loaded explosive can be controlled more accurately and a higher resistance to vibration and shock environments can be achieved.

- **Hardware and explosives**—The choice of the explosive formulation to be used in the vicinity of the bridgewire is dictated by the application of the EBW. There are various explosives, explosive mixtures, igniter mixes and propellants now being used in EBW devices. But if these materials approach either the electrical or mechanical sensitivities of primary explosives, the inherent safety is lost. The explosive material should be at least as insensitive as PETN.

Even PETN is not generally accepted for use in Navy standard munitions unless it is mechanically shuttered from the more insensitive explosives of the munition.

The explosive must be further defined in terms of purity, crystal structure, particle size, and particle size distribution. To obtain a particular crystal form or purity usually requires special processing such as milling. All of these factors play an important part in the reliability of initiation of the device.

Of equal or even greater importance is the density at which the explosive is loaded. Small changes in density (0.1 g/m^3) can make the difference between high-order initiation and failure. Explosive loading in the vicinity of the bridgewire up to now has been at a relatively low density; approximately 1.0 g/m^3) for PETN.

Although the EBW device is easier to initiate when the explosive is loaded at the lower densities, it is desirable to load the explosive at as high a density as tolerable. This will help overcome adverse environmental forces such as vibration, set-back, and impact. Also, higher detonation velocities can be realized. The density problem will disappear when power supplies become available that can deliver greater energy at higher rates.

- **Safety requirements**—In addition to the special requirements imposed on a particular EBW because of its application and environment, there should be a set of minimum safety requirements applicable to all devices in this category that will be acceptable to the military services. The tests elected should consider handling, shipping, storage and environment.

Typical tests are listed below. They are not all-inclusive; others may be added as the need arises.

1) MIL-STD 300 series (Jolt, Jumble, 40-ft-drop, etc.).

2) No fire when the bridgewire is subjected to 250v dc.

3) No fire when 2 amperes (constant current) are passed for a minimum of five minutes.

4) No fire when pulsed from a 500 picofarad capacitor charged to 25,000 volts.

5) No fire when exposed to a radio frequency (RF) field of 100 watts/M^2 over the frequency range 40 kc to 46 gigacycles.

6) Auto ignition temperature of 300°F or greater.

The acceptance or rejection of the EBW caused by duds resulting from these tests can be at the judgment of the user. The number of items should be based on the reliability and confidence levels desired. ■

AF Seeks Renewed X-15 Interest

Dyna-Soar demise leaves program as sole maneuverable manned re-entry vehicle; Plane No. 2 extensively modified after crash

by Russell Hawkes

THE AIR FORCE is starting a campaign to get more industry attention for the *X-15* program, which has been overshadowed lately by bigger and more spectacular space projects.

One of the first guns of the campaign was fired by *X-15* project officer Col. Elmer Smith at Edwards AFB, Calif., recently in a conference on the testing of manned space systems. He chastised industry officials for losing interest in the project now that its glamor has worn off, and he emphasized that the three rocket-powered aircraft still offer unique opportunities for space and aircraft research and still offer a market for some of the industry's advanced capabilities.

Cancellation of the *X-20 Dyna-Soar* program adds weight to Smith's observation, since it leaves the *X-15* as the nearest thing to a maneuverable manned re-entry vehicle now available in the U.S. Smith predicted another four to five years of valuable flight research for the project, barring the loss of an airplane.

The North American Aviation-built *X-15* was originally intended to have a two-year career, but the three built have already been in service for three years.

• **Plane No. 2 repaired**—Within the scope of present planning, the number two aircraft—officially the *X-15 A-2*—should be the most valuable. Capitalizing on the need to rebuild the *X-15 A-2* extensively after a crash in November, 1962, Air Force and NASA decided to insert as much 1962 technology as possible into the 1955 design.

Target date for the official roll-out of the improved research craft is Feb. 7, 1964, and first flight will be scheduled two to four months later—when system ground tests have been completed. Manufacturing of one major structural component is now about 10 days behind schedule, but this is not expected to keep NAA from delivering the rocket plane about six weeks ahead of the contract schedule.

The *X-15 A-2* is expected to yield design data for such projects as *Aerospace Plane,* recoverable cryogenic-fueled space boosters, hypersonic air-breathing cruise vehicles such as *CLAM* (*Chemical Low-Altitude Missile*), and high-performance aircraft.

Performance goal is Mach 8 at an altitude of 100,000 ft. This is 30% faster than the basic design, but at much lower altitude than the record 354,000 ft. to which *X-15* has been flown. The features sought in the *X-15 A-2* improvements primarily are more time to conduct tests at high speeds and altitudes and a larger and more extensive experimental payload capability.

Ultimately, it will make possible 4 min. 15 sec. of test time at speeds above Mach 5. Flights at a constant dynamic pressure of 1,500 psf will be somewhat shorter but still much longer than any to date.

• **Refinements still pending**—The *X-15 A-2* will not be able to achieve these things immediately after it comes out of the NAA modification hangar in February. After initial flight tests, all surfaces of the airplane must be coated with an ablative material to keep structural temperatures under the 1,200°F design limit. The technique of jettisoning the large external fuel tanks must also be more fully developed.

Provisions for special payloads extending the research potential of the *X-15* design include a removable right wingtip that can be replaced with structural specimens to be investigated. The original wingtip was destroyed in the 1962 crash. The detachable section includes the outboard 44 in. of the wing.

Air Force Systems Command is considering a plan to prepare an *X-15* wingtip of columbium to evaluate that material for future air and space vehicles.

The Federal Aviation Administration has expressed a desire to evaluate structural concepts for supersonic transport airfoils by trying them out on *X-15* wings. However, no contracts have yet been signed. Smaller structural samples can be tested in rectangular sections of one of the detachable wings. This enables USAF and NASA engineers to evaluate heating and aerodynamic interactions on a material, substructure design, or abalative coating before committing the safety of the aircraft and its pilot to the new idea.

The replaceable panels are heavily instrumented with such equipment as microphones, strain gauges, thermocouples and dynamic pressure rakes. There are arrangements to pump liquids or gasses to these small panels for tests of transpiration or film cooling.

• **Flight schedule coordination**—The mission schedule for the Mach 8 rocket plane is still being worked out by the Air Force and NASA. The length of the *X-15 A-2* fuselage has been increased by a 27-in. bay inserted between the fuel tank and the oxidizer tank near the center of gravity. The bay can carry additional flight test instrumentation, but it was installed mainly to hold a pair of 24-in. x 45-in. cylindrical liquid hydrogen tanks.

Plumbing has been provided to carry the liquid hydrogen to the lower vertical fin. It is intended to install a liquid hydrogen-fueled ramjet there for tests that will probably be scheduled some time after 1966.

Hydrocarbon fuels are apt to be used in first ramjet tests rather than liquid hydrogen. Until then, liquid hydrogen can be pumped to the backplate of structural samples installed in the lower vertical fin to study the effect of extreme thermal gradients.

The hydrogen can stabilize the internal temperature at about —425°F and aerodynamic heating can raise the external temperature as high as 2,500°F. Differences in thermal expansion can make structures under a high-velocity air load more susceptible to destructive flutter. The liquid hydrogen also might be used to experiment with methods of air liquefaction proposed for space planes.

• **Star photography planned**—The first research mission of the *X-15 A-2* will be to carry instruments for stellar photographic experiments being conducted under the supervision of the University of Wisconsin, designed to lead to space navigation and control systems.

A special "flip-top" compartment has been provided for the instruments directly behind the cockpit. It will open in the rarified atmosphere at altitudes above 250,000 ft. to expose a 16-in. x 40-in. opening in which the stellar camera will operate. The compartment is designed so that it is also possible to point instrumentation downward out the belly.

After the stellar photo job, the *X-15 A-2* will carry other instruments in the same compartment to analyze the light spectrum at the Earth's horizon as seen from a near-orbital altitude. For this study, the vehicle will be rolled into a vertical-banked attitude so that instruments can scan vertically through the band of colors visible at the horizon.

A small box for ultraviolet spectrometers has been designed at the base of the upper vertical fin. These will be used to study the ultraviolet radiation in the exhaust plume of the *X-15's* Thiokol LR-99 engine and the ultraviolet background of the Earth's surface. Data about the latter is expected to be used in the development of passive ultraviolet surveillance systems.

• **Futures of Nos. 1 & 3**—Experiments are also being prepared for the unmodified *X-15's*. A pair of micrometeoroid-detection packages are now being readied for installation on the *X-15 A-1*. They are in cylindrical capsules 8 in. in diameter and 60 in. long to be installed in the wingtips. There will also be experimental packages to measure atmospheric density at high altitudes.

At least initially, high altitudes will remain the province of the *X-15 A-3*, because the attitude-control system of the *X-15 A-2* is less satisfactory for this purpose. However, the altitude capability of an *X-15* is re-entry heating-limited and not power-limited. The Thiokol LR-99 and the amount of propellants planned are capable of lifting the craft to beyond 500,000 ft.

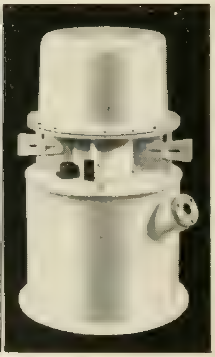
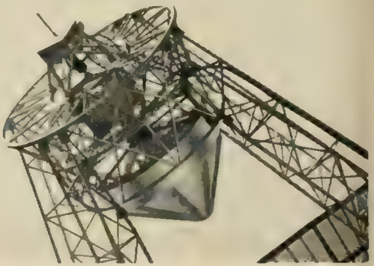
The special anti-heating features provided in the *X-15 A-2* make it the only one of the three capable of surviving a trip to that region. Therefore, it can be expected that if NASA will approve an extension of the altitude envelope, a better control system will be installed. In experiments requiring high dynamic pressure, *X-15 A-2* will be able to achieve 2,200 psf briefly.

Among the *X-15* studies being discussed for the distant future is an investigation of combustion in supersonic flow. The data is needed for development of very-high-performance ramjets and turbo-ramjets. Internal flow is subsonic in all engines now under development and supersonic combustion has never been established.

The *X-15* experiment package would be intended not to deliver significant thrust but to determine at what combination of speed and altitude supersonic combustion engines become preferable to subsonic, and to investigate basic mechanisms such as flame propagation.

The *X-15* system project office in AFSC Aeronautical Systems Div. is asking industry to come forward with new ablative coating formulations that might be applied to the *X-15 A-2*. Emerson Electric Thermo-Lag 500, a proprietary formulation, is highly favored to win the job.

In flight tests aboard *Scout* and *Saturn* rockets and in plasma-jet tests by NAA, it has been found to have very desirable physical properties. However, in its present form, it must be heat-cured on the vehicle for two hours at 300°F and two more hours at 200°F. ■

Feeds for thought!

Scientific-Atlanta's Nutating Feeds & Antennas Program

If you haven't been thinking of Scientific-Atlanta, when you think of specialized antenna projects, please start thinking now! Scientific-Atlanta has a considerable interest in specialized antenna projects, including all phases of complex development, study, and testing programs. The company's record in this field includes: design, fabrication, testing, and delivery in 90 days of two high-performance circularly polarized nutating feeds, 215 to 260 Mc, for 60-foot tracking antennas plus very broad band, polarization diversity, nutating feeds, covering all telemetry bands, for 85-foot tracking antennas for use in Atlantic and Pacific Missile Ranges; pioneer development and manufacture of the three-dimensional-dielectric Luneberg Lens; a 35 GC low-sidelobe paraboloidal antenna achieving better than 30 db sidelobe suppression over a 12% bandwidth; a high-power radio astronomy antenna feed, dual-polarized and capable of handling 60 KW, for a 150-foot reflector; plus many other unique applications over the broad range of the antenna field. Think now and write to: Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta, Georgia 30324
▪ Phone: 404 938-2930 TWX: 404 938-1322

Scientific-Atlanta, Inc. SA

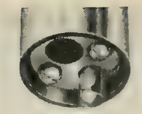
Circle No. 6 on Subscriber Service Card

We could build his trainer by applying all of our experience on submarine and aircraft trainers, space suits, digital computers, life science projects and optical displays. We have built trainers that take submariners down deep, through every undersea maneuver and hazard imaginable, miles from the nearest salt water. We wrote the specifications for the F-105 trainer. Pilots fly it at 50,000 feet and 1400 miles per hour, in a quiet little room. And for years we've been researching the problems related to space trainers such as those that will be needed for NASA's moon shot and other space voyages. The men who design these trainers first project themselves into the vehicle, in the alien environment, and anticipate every conceivable hazard. Then they make a mathematical model of the vehicle and its mission. They program logic circuits for every event including errors and breakdowns—every sight, sound, touch and smell—the crew might encounter. They build a working duplicate of the control center, complete. And finally they add a console where an instructor can put the crewmen through the journey over and over again until every single detail of it becomes routine. When it comes to training people for survival in hostile environments, Republic knows its business. Even though all our experience so far happens to be with Earthmen. **REPUBLIC AVIATION CORPORATION**

We could train a Martian to orbit the earth, land a complicated vehicle, make scientific observations and get back to Mars to tell about it.

Republic Aviation Corporation, Farmingdale, Long Island, New York

New Grinnell Primac® Fire Control Systems* provide instant detection...ultra-fast protection ...at Thiokol



1. Photosensitive cell detects fire

2. Electronic control receives signal

3. Primac valve is instantly triggered

At Thiokol Chemical Corporation's solid fuel plant in Elkton, Md., fire protection must be ultra fast...one hundred percent effective. Thiokol gets this kind of protection with a Grinnell Primac Fire Control System.

When fire struck in Thiokol's solid fuel mixing operation, strategically-located photosensitive cells detected the flash. With the speed of light, an electronic control signaled the Primac valve—and a deluge of water spray held fire damage to a minimum. The mixer was only slightly damaged, and there was no serious production loss.

Whatever your fire protection or piping needs—special hazards systems, hangers, valves, prefabrication, piping accessories—you can depend on Grinnell. Offices and engineers in 66 major cities. Write—Grinnell Company, Inc., 277 West Exchange Street, Providence 1, R. I.

*U.S. Pat. No. 3064739

GRINNELL
Fire protection systems since 1878

Circle No. 7 on Subscriber Service Card

Mergers and Acquisitions

Directors of Litton Industries, Inc., on Dec. 6 gave final approval to the purchase of assets of Clifton Precision Products Co., Clifton Heights, Pa., missile/space and aircraft electronics manufacturer. Voting on the acquisition was delayed until settlement of an electrical workers strike against Clifton. Terms of acquisition require Litton to issue common stock and notes in exchange for Clifton's outstanding shares. Clifton shareholders have the option of receiving the equivalent of $24.75 in Litton stock for each Clifton share, or $20 in Litton stock plus Litton's promise to pay $7.20 after five years at 4½% annual interest for each Clifton share. . . . *Alpha Wire Corp., New York, Loral Electronics Corp. subsidiary, has acquired the physical assets of the U.S. Wire and Cable Div. from Dodge Wire Corp. U.S. Wire and Cable, located in Union, N.J., is a producer of military and industrial coaxial cable. The acquisition increases Alpha Wire's sales capabilities in the coaxial cable market.*

New Firms and Divisions

Vacuum Industries, Inc., a new wholly-owned subsidiary of Geophysics Corp. of America, has been formed in Bedford, Mass. The firm consolidates the manufacturing and marketing activities of GCA's two former vacuum products subsidiaries, Vacuum Specialties, Inc., and Vactek, Inc. . . . *Maremont Corp., Chicago, has realigned its research laboratory, previously an arm of Maremont's Rocket Power, Inc., subsidiary, to function as a division of the parent firm. The laboratory, to be known as the Pasadena Research Div., will expand operations to include studies in other than the missile/space field.* . . . A life sciences department has been organized at the Westinghouse Research Laboratories, Pittsburgh, to carry out research in the so-called scientific "interfaces" that now exist among the physical and biological sciences.

SEC-ARC Dispute Continues

Controversy between the Atlantic Research Corp. and the Securities and Exchange Commission has flared up again over an ARC registration statement filed in July, 1962. The SEC, in a commission opinion and stop order action dated Dec. 6, charges that hearings on the firm's business transactions reveal "false and misleading statements" in respect to two ARC subsidiaries, and specifically, with the purchase of company stock by the subsidiaries with funds provided by ARC. This action was "for the purpose and with the effect of manipulating the price of (ARC) stock," says the SEC report. In a reply dated Dec. 7, ARC complained that in the SEC's "star-chamber" hearings, the firm was not allowed to introduce evidence in its own behalf and was denied right to legal counsel. ARC spokesmen say company attorneys plan "to seek judicial relief in the Federal courts," with the "conviction that under normal court proceedings . . . a fair presentation of facts will invalidate the conclusions reached by the SEC in its investigation."

International

Amphenol-Borg Electronics Corp., Broadview, Ill., and Rohde & Schwarz, Munich, Germany, have reached an agreement under which FXR, a division of Amphenol-Borg, will manufacture the R&S line of high-precision coaxial connectors in the U.S. FXR will be licensed to sell the product everywhere except Europe and Africa. . . . *L.M. Ericsson Pty., Ltd., a subsidiary of L.M. Ericsson Telephone Co., Sweden, has opened a manufacturing facility in Broadmeadows, Australia. The plant will manufacture telephone switching equipment and other telecommunications devices. Ericsson has operations in 75 countries, including North Electric Co., Galion, Ohio.* . . . Schrack Electrical Sales Corp., American sales organization of E. Schrack Elektrizitats, Vienna, Austria, has moved to new headquarters at 1140 Broadway, New York City. Schrack products include open types, closed types, plug-ins, sensitive plate relays, latching types, miniatures and compact rotary stepping switches. . . . *Minneapolis-Honeywell Regulator Co. has opened a 100,000-sq.-ft. plant in Newhouse, Lanarkshire, Scotland, for the manufacture of medium and large computer systems. The systems will be marketed in the United Kingdom and Commonwealth countries.* . . . General Dynamics Corp. and Ateliers de Constructions Electriques, Charleroi, Belgium, have formed a jointly owned company which will design and manufacture satellites and space tracking gear for international markets. The firm will be known as Etudes Techniques et Constructions Aerospatiales and will be located in Charleroi.

Industry Facilities

Columbus (Ohio) Div. of North American Aviation, Inc., has formed a Biological Sciences Laboratory, to be primarily devoted to research in biochemistry, physiology and toxicology. The new lab will expand the facilities of North American's Research and Development Div., especially in the areas of aerospace and undersea technologies. . . . *The American Institute of Aeronautics and Astronautics has moved its headquarters to 1290 Avenue of the Americas, New York City.* . . . International Telephone and Telegraph Corp. has opened a new office in Honolulu, Hawaii, under the management of Bernard Corcoran. The office is part of ITT's U.S. Defense and Space Group Field Marketing Operations. . . . *Edgerton, Germeshausen & Greir, Inc., Boston, has completed a 35,000-sq.-ft. research facility in Santa Barbara, Calif. In addition to a separate structure housing a 3-18 Mev Linear accelerator, the new plant expands facilities for the company's advanced research programs in nuclear physics and electronic instrumentation.*

contracts and procurements

AWARDS

AIR FORCE

$32,635,000—**Avco Corp.'s Research and Advanced Development Div.,** Wilmington, Mass., for a re-entry vehicle vulnerability test program on Project *Sleigh Ride.*

$5,400,000—**Olin Mathieson Chemical Corp.,** Saltville, Va., for production of hydrazine liquid propellants for rocket engines.

$4,000,000—**Boeing Co.,** Seattle, for continued work on *Minuteman* missiles.

$3,000,000—**Texas Instruments, Inc.,** Dallas, for radar equipment production.

$1,800,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for conversion of a launch pad at Point Arguello, Calif.

$1,800,000—**Sanders Associates, Inc.,** Nashua, N.H., for electronics equipment.

$1,000,000—**Philco Corp.'s Aeronutronic Div.,** Newport Beach, Calif., for improvement of techniques to penetrate enemy ICBM defense systems.

$459,000—**General Precision's Aerospace Systems Div.,** Little Falls, N.J., for a two-year flight test program on the Miniature Inertial Navigation System (MINS).

$300,000—**Burton Manufacturing Co.'s Trans Electronics Div.,** Van Nuys, Calif., for production of a large quantity of electronic equipment.

$58,747—**Jutco, Inc.,** Gardena, Calif., for a guidance vehicle.

$51,000—**University of Southern California,** Los Angeles, for research on the spectra of crystals.

$30,373—**Trustees of Princeton University,** Princeton, N.J., for liquid propellant rocket motor combustion processes.

ARMY

$31,800,000—**Raytheon Co.,** Andover, Mass., for further work on the *Hawk* missile system, including guidance and control sections and the missile itself (two contracts).

$5,000,000—**General Telephone and Electronics Corp.,** Needham, Mass., for production of spare parts for advanced electronic communication equipment.

$3,700,000—**Technical Material Corp.,** Alexandria, Va., for transportable communications equipment.

$550,000—**Hughes Aircraft Co.,** Culver City, Calif., for further research and development on the *TOW* missile.

$300,000—**ACF Industries, Inc., ACF Electronics Div.,** Paramus, N.J., for the development of a coherent microwave beacon for use in space applications at the White Sands Missile Range, N.M.

$176,440—**C. A. Meyer Paving and Construction Co.,** Orlando, Fla., for preparing the site for the industrial water supply system at Launch Complex 39, Merritt Island, Fla.

$46,594—**Microwave Associates, Inc.,** Burlington, Mass., for specialized electron tubes.

$35,804—**Raytheon Co.,** Andover, Mass., for Project ARPAT target post-flight analysis.

NAVY

$1,037,900—**Interstate Electronics,** Anaheim, Calif., for the fabrication of addition test instrumentation for the *Polaris* program.

$900,000—**Radio Corp. of America, Communications Systems Div.,** New York City, for construction of 14 intercommunications systems for nuclear powered submarines.

$375,000—**Gorham Corp., Pickard & Burns Electronics Div.,** Waltham, Mass., for production of VLF antenna systems.

NASA

$364,842—**Union Carbide Corp.,** Chicago, for service and supply of liquid helium.

$315,000—**Ion Physics Corp.,** Burlington, Mass., for a micrometeoroid impact simulator.

$293,657—**Hercules Powder Co.,** Wilmington, Del., for rocket motors.

$213,000—**Martin Co.,** Baltimore, for a research model of an advanced structural and thermal protection system.

$49,000—**North American Aviation, Inc., Space and Information Systems Div.,** Downey, Calif., for amendment to a current contract for a study of the *Apollo* spacecraft as a space sciences laboratory.

$47,234—**Electro-Mechanical Systems, Inc.,** Titusville, Fla., for LOX cleaning services.

Computer Products, Inc., Belmar, N.J., for a MARK T-50 analog computer (undisclosed amount).

ATOMIC ENERGY COMMISSION

$400,000—**Union Carbide Corp.,** New York City, for furnishing carbon and graphite components for an advanced nuclear reactor system experiment being built at Los Alamos, N.M.

ADVANCED RESEARCH PROJECTS AGENCY

$3,000,000—**United ElectroDynamics, Inc.,** Pasadena, Calif., for continued operation of the agency's Data Analysis and Technique Development Center in Alexandria, Va.

INDUSTRY

$5,000,000—**Garrett-AiResearch Mfg. Co.,** Los Angeles, from **Grumman Aircraft Engineering Corp.,** for furnishing the cryogenic hydrogen and oxygen storage system for the *Apollo* Lunar Excursion Module program.

$1,000,000—**Talley Industries,** Mesa, Ariz., from the **Boeing Co.,** for actuators for *Minuteman* ICBM site support gear.

$1,000,000—**Computer Sciences Corp.,** San Francisco, from **Lockheed Missiles & Space Co.,** for programming services and support (seven contracts).

$1,000,000—**Ling-Temco-Vought, Inc.,** Dallas, from **United Technology Center,** for production of the pitch and yaw controller for the first-stage rocket motors to be used on the *Titan III-C.*

$850,000—**Haveg Reinhold, Inc.,** Santa Fe Springs, Calif., from **Thiokol Chemical Corp.,** for reinforced plastic components.

$750,000—**PneumoDynamics Corp., Cleveland Pneumatic Div.,** Cleveland, from **Aerojet-General Corp.,** for 28 *Minuteman* ICBM nozzles.

$700,000—**Coors Porcelain Co.,** Golden, Colo., from **Lawrence Radiation Laboratory,** for continued research and development of nuclear ceramic fuel elements for Project *Pluto.*

$533,000—**Advanced Technology Laboratories,** Mountain View, Calif., from **United Technology Center,** for work in connection with the first-stage rocket motors of the *Titan III-C.*

$500,000—**Douglas Aircraft Co.'s Tulsa Div.,** Okla., from **Lockheed Missiles & Space Co.,** for fabrication of spacecraft fairings to protect *Gemini's* docking adapter during booster flight.

$500,000—**Systron-Donner Corp., Donner Div.,** Concord, Calif., from **Lockheed's Missiles and Space Co.,** for ignition programmers for the *A3X Polaris.*

$400,000—**Computer Sciences Corp.,** El Segundo, Calif., from the **Jet Propulsion Laboratory,** for work on the Space Flight Operations Facility (SFOF) which will be used to control NASA's unmanned lunar and interplanetary space probes.

$134,823—**Giannini Controls Corp.'s Instrument Div.,** Santa Ana, Calif., from **United Technology Center,** for delivery of 50 self-powered shock-recording systems to be used for monitoring railroad shipment of *Titan III-C* boosters from Sunnyvale, Calif., to Cape Kennedy, Fla.

$100,000—**Products Research Co.,** Burbank, Calif., from **Boeing Co.,** for a molding and potting compound used in the weapons system of the *Minuteman* missile.

$71,000—**Ryan Aeronautical Co.,** San Diego, from the **Boeing Co.,** for providing a quantity of separation rings, circular members between stages of the *Minuteman* missile's propulsion system.

$51,000—**Controlled Products and Electronics, Inc.,** Huntington Park, Calif., from the **Boeing Co.,** for *Minuteman* missile assemblies.

Computer Control Co., Inc., Framingham, Mass., from **Lockheed Electronics,** for a digital resolver (undisclosed amount).

Newport News Shipbuilding and Drydock Co., Newport News, Va., from **Thiokol Chemical Corp.,** for the fabrication of two large rocket motor cases 260 in. dia. and 60 ft. long (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Bureau of Naval Weapons
Washington, D.C.
20360

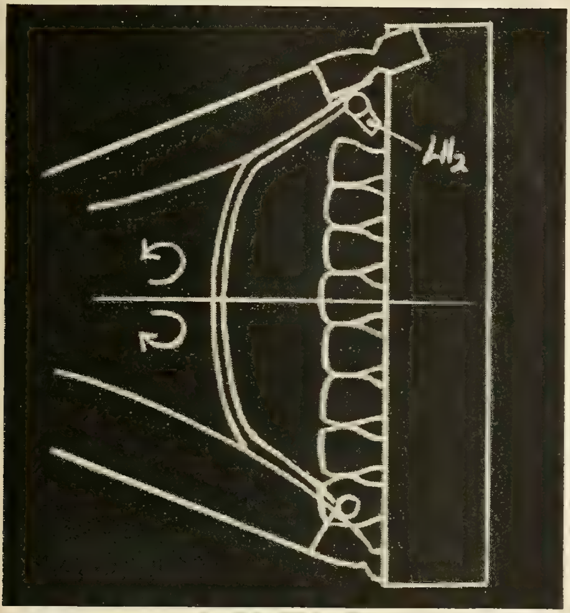
Conduct a production compression capability study on *Talos* missiles to determine the capability of the contractor to produce an increased quantity of *Talos's* within a designated compression period. The Bureau of Naval Weapons contemplates award of a contract to Bendix Corp., Mishawaka Div., Mishawaka, Ind. This firm is the sole source for *Talos* missiles and award will be made on the basis of that contractor's proposal. This notice is for information only. C/N 2701-64. BuWeps Synopsis No. 341-64.

U.S. Army Missile Command
Redstone Arsenal, Ala.
(AMSMI-IXG)

Contract for engineering design and manufacturing support of guided missile motor development and solid propellant programs to be negotiated with Thiokol Chemical Corp., Alpha Div., Huntsville, Ala. Modification to contract DA-01-021-ORD-1-919 (Z). It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the firm listed.

HIGHLY QUALIFIED PROPULSION ENGINEERS

WORK ON PROBLEMS LIKE THIS...



An annular cluster of engines is used to form a truncated plug nozzle. How do we provide efficient cooling of the plug under varying engine conditions and during engine-first re-entry from orbit?

WITH ASSOCIATES LIKE THESE...

R. H. Michaelis is currently responsible for propulsion system design and analysis for advanced launch vehicles. Previous assignments include studies of manned lunar landings, orbital propellant storage, and high energy upper stages; the design of various Saturn S-IV propulsion subsystems; and the deployment of Thor IRBMs in England.

Mrs. M. L. Williams is presently conducting research on advanced propellants and combustion. Her background includes 13 years of experience with U.S. Naval Ordnance in the fields of physical chemistry, propellant process development, and propellant research. She is a member of ReSA, an Associate Fellow of AIAA and the author of many technical papers.

...IN THIS PROFESSIONAL ATMOSPHERE

The Douglas Advance Space Technology Department is a professional community charged with the responsibility of evolving new concepts for the nation's space program.

It combines research and advance design functions in a self-administered unit having the atmosphere of a small, highly qualified engineering organization. But it also has the advantage of having at hand the vast support functions and facilities of a major aerospace company. Its studies are tempered by the scientific critique of its research groups and the realism required by the knowledge that eventually "hardware" end products are involved.

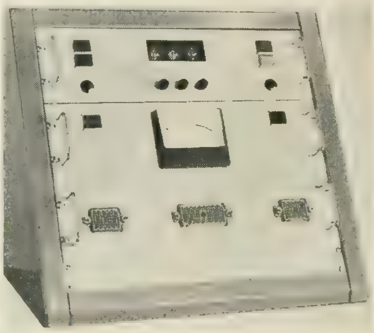
AN INVITATION. Key openings are now available in the Propulsion Branch for qualified professionals with experience and/or advanced degrees, in all areas of rocket propulsion; i.e., chemical, nuclear and electric. We invite you to look into them by writing (please include resume) to the following address:

Mr. W. S. Ames

DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION
2700 Ocean Park Boulevard, Santa Monica, California
An equal opportunity employer

New Product of the Week: Cable Analyzer



An instrument for automatically testing cables, wiring harnesses and other multiple circuits is being marketed by Automation Dynamics Corp.

The Model 223 Cable Analyzer is of modular design to permit increasing the number of test points and checks. Tests are performed in automatic sequence with go, no-go indication, numerical read-out or graphic chart indication.

The instrument has a capacity of 50 circuits and its capacity can be increased in 50-circuit increments. Maximum hi-pot test voltage is 1,000v; rejection limit in the high-voltage leakage test goes up to 1,000 megohms. Continuity limits may be set from 1 to 25 ohms.

Circle No. 225 on Subscriber Service Card

Pulse Transformer

A high power direct magnetron-mounted pulse transformer has been introduced by Nytronics, Inc.

The unit is rated at 15,000v, 15 amperes, at a pulse duration of 0.32 to 3.2 µsec. It provides safe handling of 40,000-v pulses encountered during magnetron misfiring.

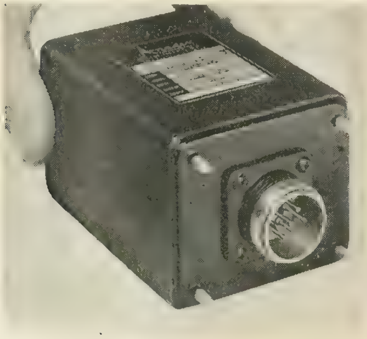
Input impedance is 50 ohms; output impedance is 1,000 ohms. Duty cycle is 0.001 second. Pulse droop is less than 6% when fired into a 1,000-ohm load. Inducted voltage of 8,000v input, 36,000v output, can be withstood for short periods. The device operates at ambients of —55° to 125°C.

Circle No. 226 on Subscriber Service Card

Frequency-to-DC Converter

A frequency-to-dc converter for industrial process control applications has been developed by Anadex Instruments, Inc.

The Model PI-309P provides 1 to 5 milliamp output and full scale frequencies from 100 cps to 5 kc. Internal potentiometers permit full scale adjustment of ±10%. DC output is proportional to input frequency within ±0.2% of full scale.



Power input is 115v, 60 to 400 cps. Temperature range is —55° to 165°F.

Circle No. 227 on Subscriber Service Card

Flip-Flop Module

Scientific Data Systems is marketing an all-silicon basic flip-flop module, which can operate as a general purpose storage, binary counter, decade counter, shift register or repeater flip-flop.

The unit has four flip-flops that operate independently except for the common dc reset input line. Operating range is 0° to 100°C.

The module is available in two models. The FC20 has a maximum operating frequency of 300 kc, and the FH20 has a maximum operating frequency of 1 mc. Both models will drive a maximum of 12 loads.

Circle No. 228 on Subscriber Service Card

Separation Filter

United Transformer Corp. has available sharp cutoff low and high pass filters, with common inputs connected in parallel, packaged in one case. Source is 600 ohms. Load for each filter is 600 ohms.

The low pass filter is within 3 db from dc to 1,350 cps; it has at least 14 db attenuation at 1,410 cps and is down at least 40 db a 1,465 cps and higher frequencies.

The high pass filter is within 3 db from 100 kc to 1,470 cps, and has at least 14 db attenuation at 1,410 cps. It is down at least 40 db at 1,355 cps and lower frequencies.

The unit is guaranteed to meet MIL-F-18327B specifications.

Circle No. 229 on Subscriber Service Card

Proximity Detector

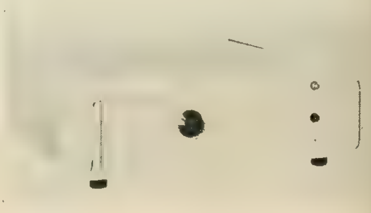
Crescent Engineering and Research Co.'s Crescent-East has developed a series of proximity detectors and gaging probes that provide amplitude voltage or pulse for counting, measuring and positioning of magnetic materials without physical contact.

The Series CE-12 detectors run from ½ to ⅞ in. in diameter and are available in plain flanged or foot-mounted configurations with cable or connector options.

Circle No. 230 on Subscriber Service Card

Frequency Synthesizer

General Technology Corp. is marketing the Models 330-A and 330-B frequency synthesizers for use in missile timing stations and radar propagation investigations.



Both models produce an output signal selectable in 1 cps steps in the range of 81.954 to 81.964 kc and an additional selectable output of 81.96427 kc. The units are designed for operation from either an ac or dc source, requiring 22 watts ac or 15 watts dc. Input power is 90 to 130v ac, 50 to 400 cps, single phase, or 23 to 31v dc.

Circle No. 231 on Subscriber Service Card

Regulated Power Module

Abbott Transistor Laboratories, Inc., is marketing a series of regulated power modules designed to convert 115-v, 400-cps power to any dc voltage from 5 to 2,000v at a power rating of 10 watts.

The Model T1D meets MIL-E-5272C requirements and will operate over a temperature range of 65 to 160°F. Regulation is ±0.5% for inputs of 105 to 125v ac and from ½ load to full load. Ripple is 0.2% RMS.

Circle No. 232 on Subscriber Service Card

Static Inverter

A line of miniature static inverters featuring adjustable sine wave outputs has been developed by Arnold Magnetics Corp. The units deliver 115v RMS, 400 cps, 50 va from a 28-v dc source. Output adjustment is ±5v RMS.

Designated the SK series, the solid-state units operate in temperatures ranging from —55° to 71°C. Frequency and voltage regulation is 0.3%. Total harmonic distortion is 4%. The units are self-protected against input polarity reversal overload and input transients.

Circle No. 233 on Subscriber Service Card

Ceramic Thermistors

Gulton Industries, Inc., has introduced a line of ceramic thermistors with positive temperature coefficient for use in switching, thermometry, current limiting and voltage regulation applications.

The Series PTC units simplify design by eliminating components in many types of circuits. Temperature coefficient is 6.0%/°C. Resistance at 25°C is 300 to 500 ohms. The units feature radial leads and measure 0.6 in. in diameter and 0.18 in. thick.

Circle No. 234 on Subscriber Service Card

Varactor Diodes

Semiconductor Div. of Sylvania Electric Products, Inc., is marketing the D-4800 series of silicon epitaxial varactor diodes, featuring hermetic welded seal construction and bonded contacts.

The diodes have a rated maximum operating junction temperature of 175°C and meet MIL-STD-19500 specifications. Individual characteristics available include: breakdown voltages from 6 to 120v; cutoff frequencies up to 160 gc measured at —6v; and junction capacitances from 0.1 to 30 pfd measured at —6v.

Circle No. 235 on Subscriber Service Card

Variable Delay System

Andersen Laboratories, Inc., is marketing a continuously variable delay system, consisting of one variable and four fixed magnetostrictive delay lines.

Each line is equipped with read and write electronics and can be connected to any other line in the system. With lines in series, total system delay is 28,000 μsec. Maximum PRF in the RZ mode is 1 mc.

Any delay within 28,000 μsec may be selected in 500 μsec increments by means of toggle switches, mounted on the front panel.

Circle No. 236 on Subscriber Service Card

Voltage Ratio Standard

General Resistance, Inc., is marketing a voltage ratio standard that accepts zero to 10 watts of power while maintaining 0.001% accuracy.

The Model VRS-101 has a maximum error limit of ±10 PPM. It features 1,000v to 10 watts maximum rated input, 100 K input resistance and an input voltage range from 1 to 1,000v dc. Absolute accuracy is maintained over an ambient temperature range of 20° to 30°C. Coefficient match is less than 0.5 PPM per degree C. Absolute stability is 0.005% per year.

Circle No. 237 on Subscriber Service Card

Shielding Materials

Reactor Experiments, Inc., is marketing a line of neutron-gamma shielding materials.

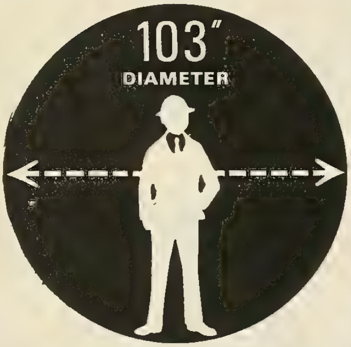
The materials utilize high hydrogen content base materials such as polyethelene, parrafin, hard rubber or epoxy. Various additives, such as lead, boron, cadmium and tungsten, may be added in appreciable portions. The additives are uniformly distributed throughout the base material, resulting in highly homogeneous mixture. Formulations and shapes can be tailored to meet specific shielding requirements.

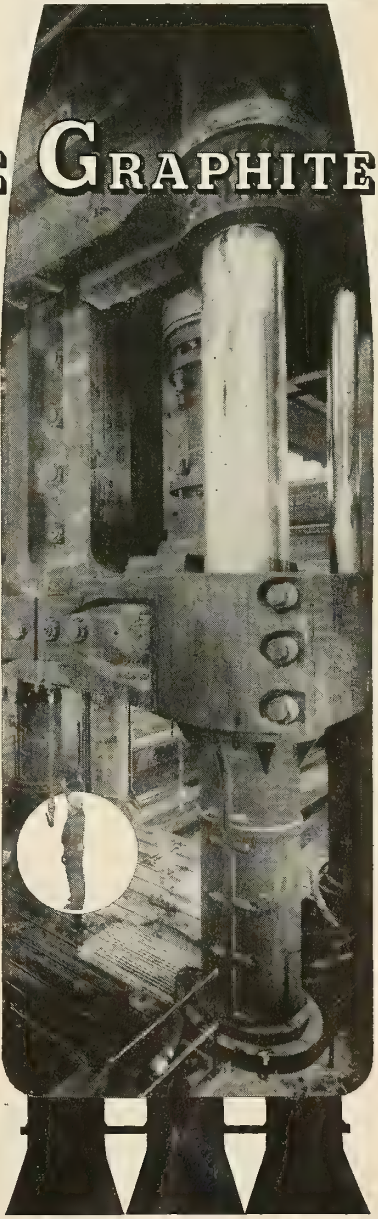
Circle No. 238 on Subscriber Service Card

COMING—

World's Largest

AEROSPACE GRAPHITE





—from the world's largest graphite forming press!

This new press is capable of exerting a force of 28,000,000 lbs.*—over twice that of any other press in the carbon and graphite industry!*

This pioneering giant is now operating to meet the aerospace industry's toughest challenges in rocket nozzle dimensions.

Sizes up to 103" diameter are already being processed. The new press has capabilities for even *larger sizes.*

Offering unparalleled capacity to produce monolithic shapes in graphite, our big press opens the way to new concepts in aerospace, nuclear, and other high-temperature applications.

"National" is a registered trade-mark of

UNION CARBIDE CORPORATION

CARBON PRODUCTS DIVISION

UNION CARBIDE

270 Park Ave., New York, N.Y. 10017

In Canada: Union Carbide Canada Limited, Toronto

Circle No. 8 on Subscriber Service Card

Neon Distribution Amplifier

Electronic Engineering Co. is marketing the Model 870 neon distribution amplifier to facilitate design of complete timing systems.

The unit can be supplied with one of three different input/output signal combinations: 1) serrated code, modulated carrier input signal, which permits exposing a dot on film for each cycle of the carrier; 2) modulated carrier input signal, which permits exposing a line of film for each modulated carrier time code group and; 3) a dc level shift input signal, which exposes a line of film for the duration of the input level shift.

Signal lines to cameras can be up to 500 ft. long for output pulse rates up to 1,000 pps, or up to 5,000 ft. for rates up to 100 pps.

Circle No. 239 on Subscriber Service Card

Metallized Paper Capacitors

Aerovox Corp. has developed a line of microminiature metallized paper capacitors suited for application where low-capacity units are being used.

The P95ZN capacitors are available in 200, 400 and 600v dc ratings with an operating temperature range of —55 to 125°C. Capacities range from 0.00005 mfd for the 600v dc units to 0.05 mfd for the 200v dc units. Case sizes range from 0.22 x 0.47 in. to 0.26 x 0.61 in.

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Random-Access Disc Memory

General Precision, Inc., has available the Model L-321 random-access disc memory, featuring a storage capacity of 180,000 bits.

The system can serve as a main memory, a buffer unit or for supplemental storage. Average access time is 25 milliseconds. Rotation speed is 1,200 rpm.

The device has a 10.3-in. disc that may be operated in any axis of rotation, reducing mounting problems.

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Glass Membranes

Permeonics Corp. has developed a microporous glass membrane consisting of millions of glass capillaries fused together in sheet form. Applications include cell filtration, zeta-coefficient investigations and fuel cell membrane research.

Capillary pores are perpendicular to the surface and are uniform throughout the thickness. When used as a filter, action occurs at the surface. The arrays are available in diameters of 2 in. and larger and may be focused and sealed into glass supports. Thicknesses are from 0.001 to 0.250 in. Pore diameters are from 1 to 100 microns.

When used as a gas particle collimater, a membrane with 12-micron-diameter pores and 600-micron thickness will produce a 5-degree beam half width.

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Guarded Scanner

Cimron Corp. is marketing the Model 1100A guarded scanner that provides high common mode rejection and allows microvolt level dc and ac voltages to be transferred and measured despite large amounts of common mode noise.

Scan is automatic or manual. Scan advance may be accomplished from external command or controlled from an internal clock with variable scan speeds from 0.1 to 20 cps.

The device accepts 600 one-wire, 300 two-wire, 200 three-wire or 100 four-to-six-wire inputs. Power dissipation is less than 12 watts.

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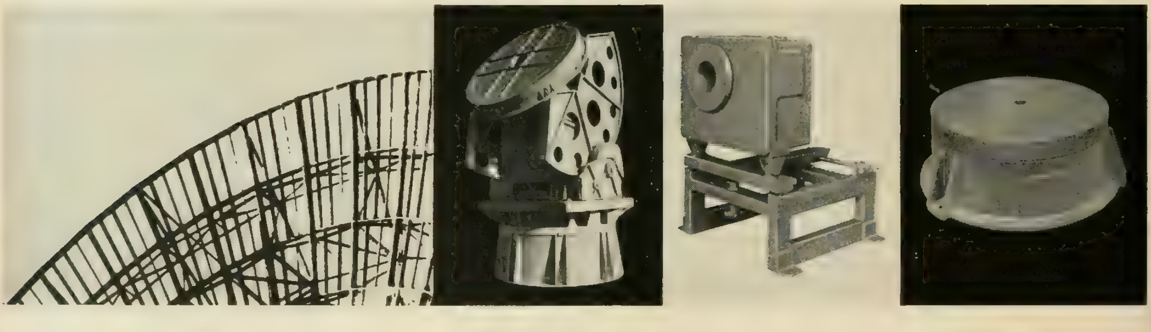

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Teflon Capacitors

Component Research Co., Inc., is marketing a line of zero-temperature coefficient teflon capacitors ranging in value from 0.001 to 10 mfd. TC ratings are as low as 0.0005%/°C with tolerances of 0.1%.

The units feature a dissipation factor of less than 0.01%, average stability with ambient storage of less than 0.03% for two years, and insulation resistance in excess of 10^{12} ohms x mfd.

Circle No. 243 on Subscriber Service Card

Weldpower Selector

Raytheon Co. has introduced the Weldpower Selector, a unified control designed to speed production welding and insure repeatability of welding conditions.

The device has six push buttons for selection of optimum welding heat, as well as a manual control knob. A 4-in. voltmeter, accurate within 1%, is mounted on the face of the device. It is calibrated in both volts and watt-seconds. A field modification kit is also supplied.

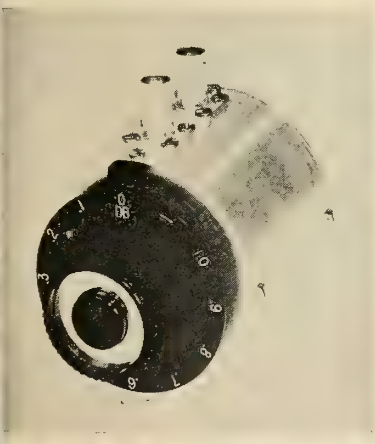
Circle No. 244 on Subscriber Service Card

Turret Attenuator

Telonic Industries, Inc., has developed a turret type RF attenuator with a full range of 1 db in steps of 0.1 db.

The Model TC-50 uses resistive pi-pads that incorporate low tolerance resistors to maximize accuracy of circuit values.

The unit operates in a frequency range of dc to 900 mc. Input impedance is 50 ohms; insertion loss is approximately 1 db. At 30 mc, the device has an accuracy of ±0.02 db with a VSWR of 1.1:1. At 900 mc, the ratings are ±0.05 db and 1.3:1 VSWR.



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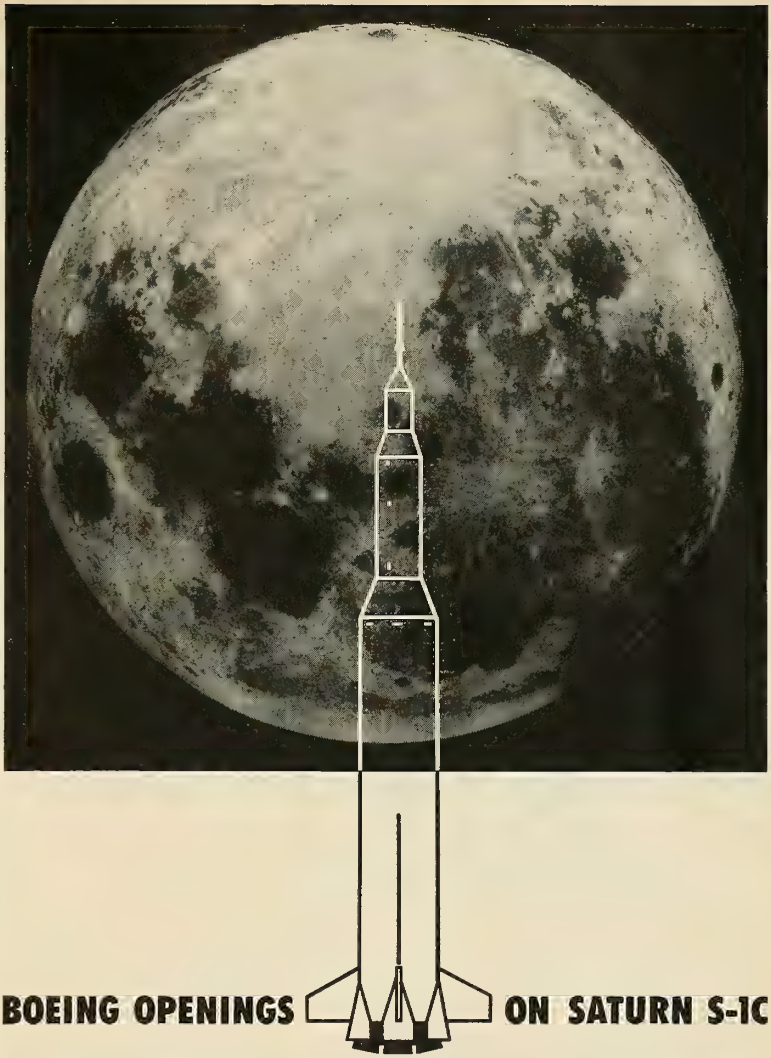

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Dr. Joseph Sternberg: Named manager of research and development for the Martin Co.'s Baltimore, Md., division.

William F. Kamsler: Appointed manager, advanced systems design for Scientific Data Systems, Inc., Santa Monica, Calif.

William H. York: Elected vice president of marketing and administration at Aerospace Research, Inc., Boston.

Donald A. Baumann: Appointed chief of engineering of Electronic Associates, Inc., Long Branch. N. J.

Dr. Don R. Berlin: Elected a vice president of Curtiss-Wright Corp., Wood-Ridge, N.J.

Buford B. Ruhl: Appointed deputy director of the Southern Interstate Nuclear Board, Atlanta, Ga.

William L. Cook: Promoted to president and general manager of the Borg-Warner Controls Div., Santa Ana, Calif.

Bernard H. Burke: Appointed quality assurance manager at Fairchild Controls Div. of Fairchild Camera and Instrument Corp., Hicksville, N.Y.

Orville E. Melby: Named treasurer of of the Boeing Co., Seattle.

Orrin G. Sage: Appointed director of performance analysis-outside production at Douglas Aircraft Co., Santa Monica, Calif.

Walter J. Polett, Jr.: Appointed director of merchandising for Allied Chemical Corp.'s Fibers Div., New York City.

Robert W. Sproul: Named chief engineer of electronic instruments for the Singer Co.'s Metrics Div., Bridgeport, Conn.

Wayne E. Harbin: Joined Applied Technology, Inc., Palo Alto, Calif., as contracts administrator in the Marketing Dept.

Richard J. Brady: Appointed by the Burroughs Corp., Detroit, Mich., as manager of communications in the Philadelphia area.

Frank H. Gardner: Joined Space Ordnance Systems, Inc., El Segundo, Calif. as production superintendent.

John C. Wyman: Appointed vice president of marketing at Duncan Electronics, Inc., Costa Mesa, Calif.

Michael F. Maguire and Thomas P. Fahy: Appointed assistant directors of engineering for the Electro-Optical Div. of Perkin-Elmer Corp., Norwalk, Conn.

Kenneth E. Hunter: Elected president and chief executive officer of Hycon Mfg. Co., Monrovia, Calif.

Dr. Carl H. von Kenschitzki: Named head of physical sciences research in the Marietta Research Center of Lockheed-Georgia Co.

Dr. Thomas S. Burkhalter: Appointed director of the Materials Research and Development Laboratory of Texas Instruments, Inc., Attleboro, Mass.

R. W. Lee: Appointed president of the Information Systems Group of General Precision, Inc., Tarrytown, N.Y.

Wesley A. Kuhrt: Promoted to associate director of research for United Aircraft Corp.'s Research Laboratories, East Hartford, Conn.

James M. Wallace: Appointed general manager of Westinghouse Electric Corp.'s East Pittsburgh, Pa., divisions.

Sidney B. Hammarlund: Appointed general sales manager of Bendix Corp.'s Bendix Products Aerospace Div., South Bend, Ind. **Robert W. Smith** named sales manager for energy absorption systems. **Robert J. A. Roden** appointed sales manager for advanced products and **Vincent P. Gibney** will continue as sales manager of propulsion controls and power systems.

Vice Admiral Frank O'Beirne (USN Ret.): Joined the staff of ARINC Research Corp., Washington, D.C., as a special advisor and consultant to the vice president.

George S. Dillon: Elected executive vice president of Air Reduction Co., Inc., New York City. **Joseph H. Humberstone** elected a group vice president.

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—when and where—

DECEMBER

Conference on Non-Linear Processes in the Ionosphere, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Dec. 16-17.

Wright Memorial Dinner, Sheraton Park Hotel, Washington, D.C., Dec. 17.

American Physical Society Meeting, Pasadena, Calif., Dec. 19-21.

American Astronomical Society Annual Meeting, College, Alaska, Dec. 26-28.

Third Western National Meeting, Space and Planetary Sciences, sponsored by the American Geophysical Union, Boulder, Colo., Dec. 26-28.

American Association for the Advancement of Science 130th Annual Meeting, Sheraton Cleveland Hotel, Cleveland, Dec. 26-30.

Society for the History of Technology Annual Meeting, New York City, Dec. 26-30.

JANUARY

Institute of Physics and the Physical Society Conference on Solid-State Physics, University of Bristol, Bristol, England, Jan. 1-4.

10th National Symposium on Reliability and Quality Control, Statler Hilton Hotel, Washington, D.C., Jan. 7-9.

National Society of Professional Engineers Winter Meeting, Westward Ho Motel, Phoenix, Ariz., Jan. 8-11.

1964 Annual Automotive Engineering Congress and Exposition, Cobo Hall, Detroit, Jan. 12-17.

146th National Meeting of the American Chemical Society, Denver, Colo., Jan. 19-24.

Aerospace Sciences Meeting, Hotel Astor, New York City, Jan. 20-22.

American Physical Society Conference on Semimetals, Columbia University, New York City, Jan. 21.

American Physical Society Meeting, Statler Hilton Hotel, New York City, Jan. 22-25.

American Mathematical Society 70th Annual Meeting, Miami, Jan. 23-27.

Second Annual Symposium on Fundamental Phenomena in the Material Sciences, Sheraton Plaza Hotel, Boston, Jan. 27-28.

Conference on Control and System Optimization, Naval Post Graduate School, Monterey, Calif., Jan. 27-29.

AIAA Solid Propellant Rocket Conference, Palo Alto, Calif., Jan. 29-31, (semi-classified).

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Can in the Sky

CANCELLATION of the *Dyna-Soar* program comes as no surprise. We wrote our eulogy to the *X-20* last March and we have no intention of repeating it now. We believe that the *X-20* was needed as a research tool to explore the technology of its flight regime. It was admittedly an extremely expensive tool, a fact that Secretary of Defense McNamara had to face in making his decision.

The door has been left open to later exploration of that technology. In concluding its statement last week on initiation by the Air Force of the *Manned Orbiting Laboratory* and *Gemini X* projects, Dept. of Defense said: "If results of the *MOL* and the unmanned re-entry program warrant, a new and more advanced ferry vehicle program may be initiated some years in the future."

If, for financial reasons, a decision had to be made between *Dyna-Soar* and *Gemini X*, we believe Mr. McNamara made the right decision. The *Gemini X* and *MOL* projects offer by far the most promising means for meeting Air Force requirements in space.

Some critics already have suggested that *Gemini X* and *MOL* are a sop thrown to the Air Force to cover up the much harsher fact of the *Dyna-Soar* cancellation. We do not believe this.

The timing of the two announcements obviously had its political basis. But the program announced publicly last week has been under study for some time and major aspects of it have been described in this magazine throughout the year.

It offers a sound and rapid route to putting the Air Force into space. Mr. McNamara made it clear that he intends to ask Congress for major funding for the program in the Fiscal 1965 budget soon to be submitted to Congress. Although declining to put an exact figure on total cost of the program as now envisioned, he sees it as one costing hundreds of millions of dollars. We estimate that it may be initiated as an $800-million program and perhaps eventually reach as high as $3 billion.

That, of course, will not be the figure requested for FY '65. But we anticipate that Mr. McNamara will be able to give Congress early next year a good idea of what the total program cost will be, since he thinks in terms of overall program packages. A Fiscal '65 budget request of about $150 million can be expected. Congress also will be asked to approve transfer of FY '64 funds to get the new program off to a rapid start.

Despite cynicism in many quarters, we believe the industry and the Air Force are confronted here with what they long have been seeking—initiation of a manned military space program with considerable promise for the future.

Dyna-Soar, at its best, was a dead-end program for development of technology—technology which we need and which admittedly we will have to seek in the future. But there was no operational future for it. The new program holds that promise.

Considerable confusion about Mr. McNamara's exact intentions was brought about by the emphasis in the Dept. of Defense press release on the *Manned Orbiting Laboratory*. Mr. McNamara made it plain in his press conference that he is as interested in *Gemini X* as in *MOL*.

Just what is the Secretary's interest in *Gemini?* He told Congress earlier this year that he foresees possible Air Force use of *Gemini* for inspection and interception of enemy satellites, and he described it as a vehicle which with slight modifications can be employed to meet many Air Force space requirements.

For those with a deeper interest in this subject, we suggest a close reading of the stories in the April 1 and June 24 issues of MISSILES AND ROCKETS by Associate Editor Frank McGuire.

THE AIR FORCE will undertake launchings in its *Gemini X* program a full year before *MOL* is launched. *MOL* is supplemental to *Gemini X*. The two are not just parts of the same spacecraft. They are both part of a broader program.

Here is the way Mr. McNamara put it: NASA developed *Gemini* as a step toward its manned lunar landing and therefore has only a limited interest in *Gemini* itself. The Air Force, on the other hand, is concerned about the possible use of man in the same environment, near-Earth orbit, for potential military purposes.

Both *Gemini X* and *MOL* will be as flexible as possible, so that they may fit into a number of roles if these develop as suitable military missions. They will lend themselves to communications, command and control, reconnaissance and surveillance, inspection and interception, ballistic missile defense and other activities if early use of the system indicates that these are feasible and desirable military missions in space.

Much confusion about the DOD announcement also resulted from press reports which tried to wrap up the whole package as a substitute for the cancelled *Dyna-Soar* program. It is not. The expanded *ASSET* project is the substitute for *Dyna-Soar* and, without question, an inferior one. There is a limit to what one can expect of *ASSET*. But it is far less expensive and some exploration of the technology will at least continue.

Gemini X and *MOL* are not *X-20* substitutes, but new and promising projects, in the sense of now having DOD approval which previously was withheld. The *Dyna-Soar* program as funded called for no operational vehicles such as these can be. We believe Mr. McNamara's decision a wise one.

With Congressional approval, Air Force and industry can set out to prove what they long have claimed—that there is indeed a manned military mission in space.

William J. Coughlin

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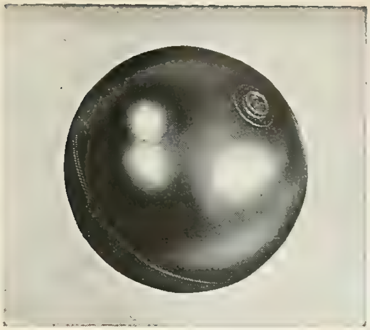
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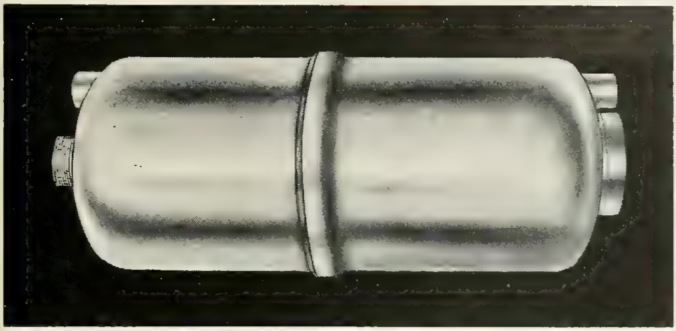
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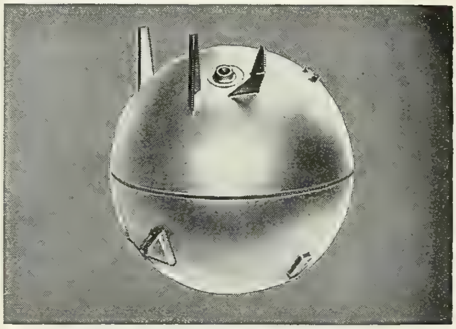
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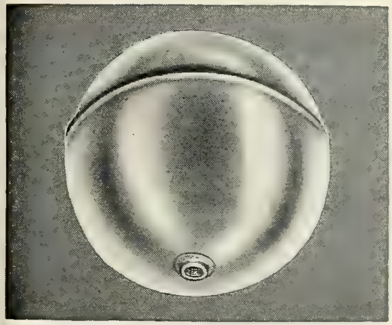
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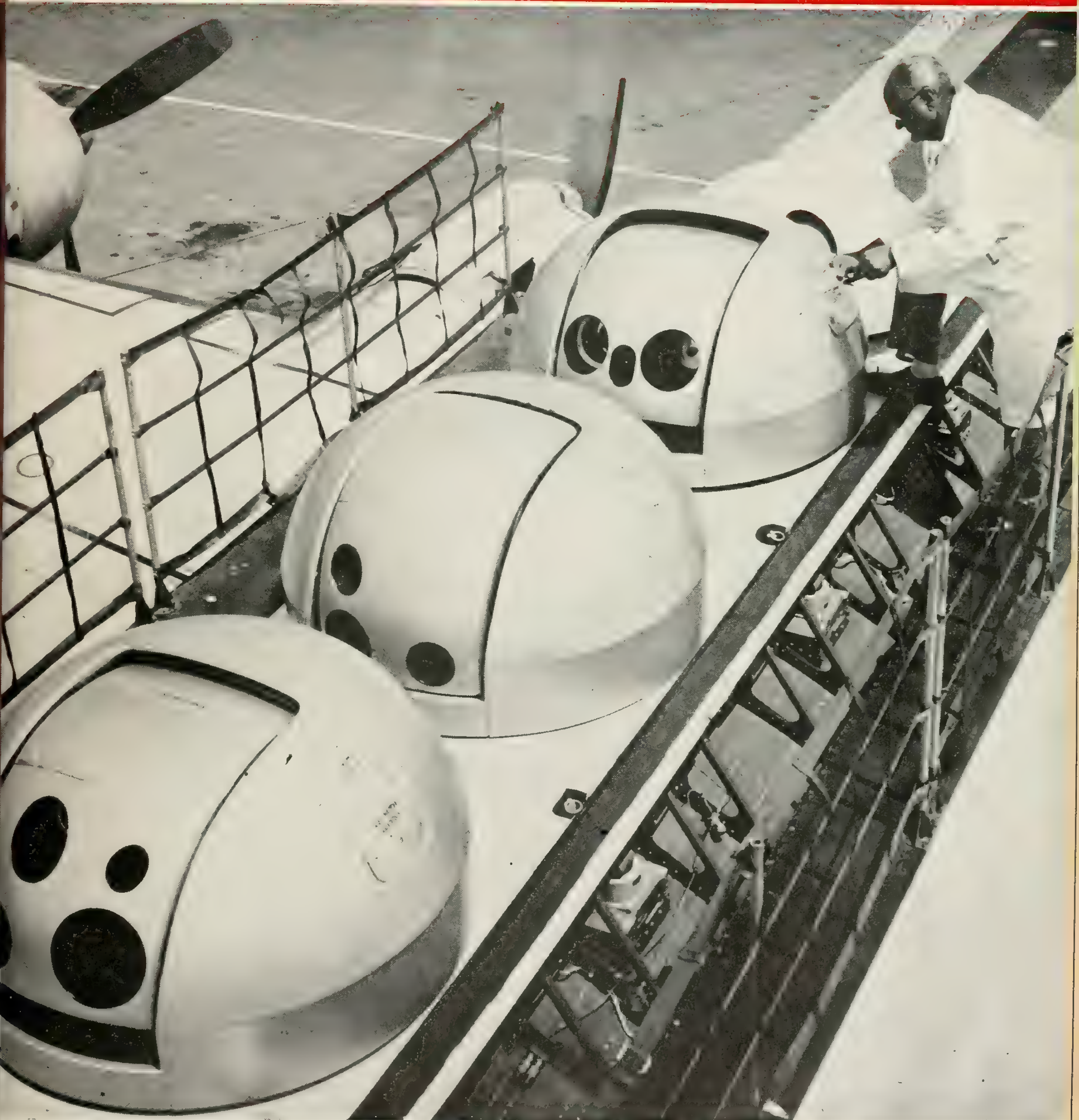

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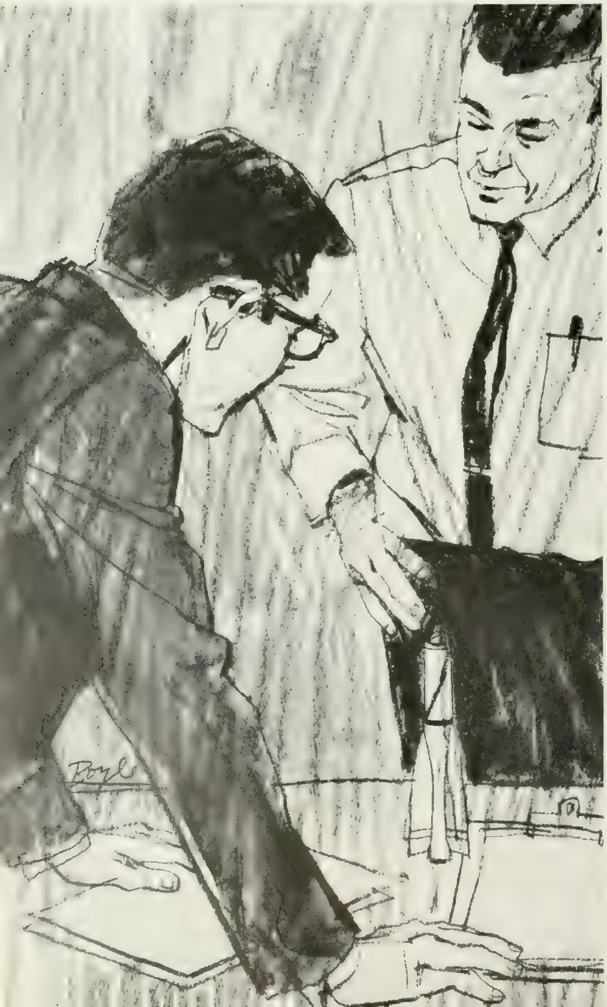
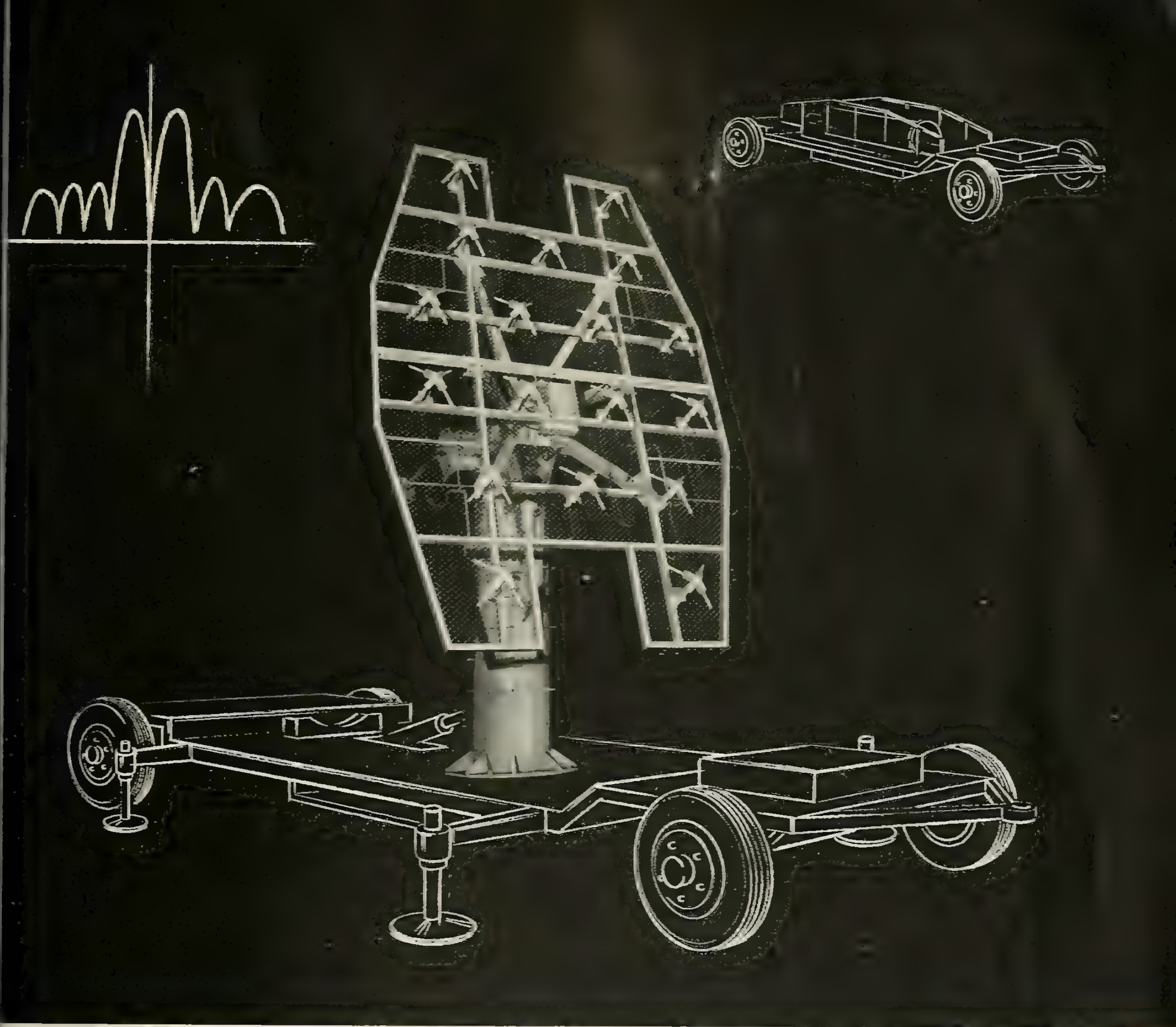
Experience: Two years minimum in one or more of the following fields: **1.** System engineering on missile or fire control systems. **2.** Field engineering on airborne fire control systems or missile systems. **3.** Test and evaluation of comparable systems. **4.** Radar systems (pulse doppler). **5.** Target tracking systems. **6.** Autopilot and control systems. **7.** Microwave systems. **8.** Digital computers. **9.** Navigation systems. **10.** Inertial components. **11.** Electrical power and armament control subsystems. **12.** Circuit design and electronic packaging.

Education: B.S. in E.E., M.E. or Physics. Articulate in communications. U.S. citizenship required.





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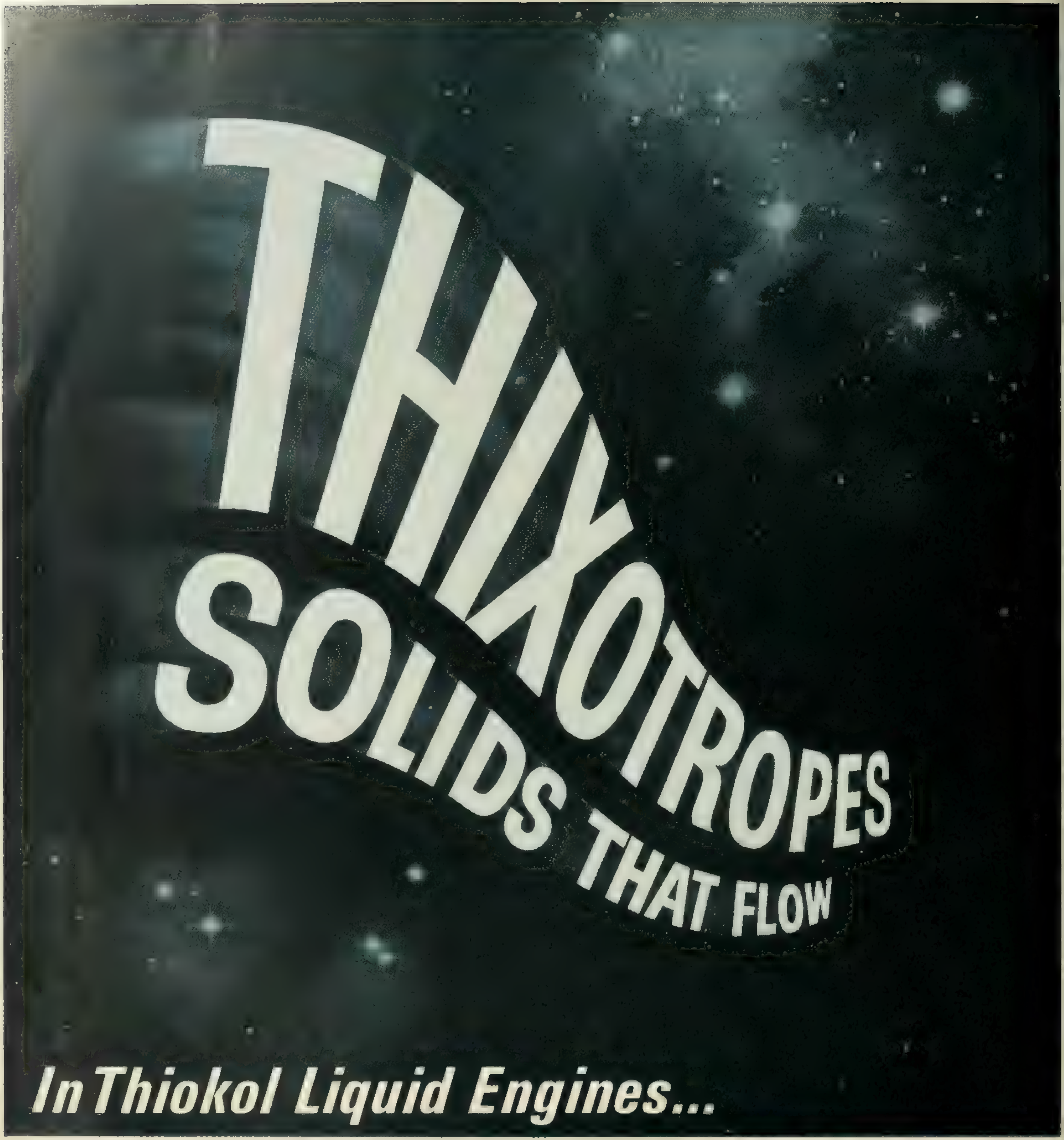

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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Volume 13, Number 26 December 23, 1963

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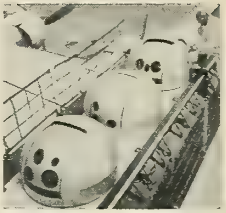

Gun-turret-type domes on C-121 aircraft modified by Lockheed Aircraft Service Co. contain optical instrumentation for the TRAP III (Terminal Radiation Airborne Program) developed by Bendix Systems Div. for the Air Force to measure radiation phenomena associated with high-speed re-entry. See p. 13.

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M/R does not publish an issue on the last Monday in December. Readers are reminded that there will be no issue on Dec. 30.

Season's Greetings—The Editors

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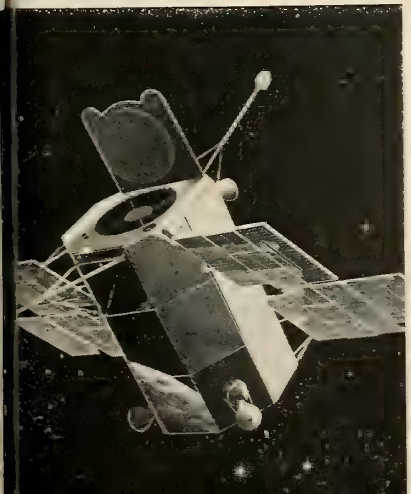

letters

Omnidirectional Power

To the Editor:

Your excellent editorial on DOD's Dr. Fubini and the need for simplification ("On Muddy Problems," M/R, Dec. 9, p. 46) prefaces problems of space flight as they are evident today. Most certainly a regression is needed—far enough back, in fact, so that some of our experts will be recognized as "horse-and-buggy" scientists who project their thoughts on steering by rein!

Could our electronics industry of today have materialized if all developments had been projected and restricted to the premise that "there is only Direct Current. and AC is a myth?"

Nevertheless, today all our space thinking and analysis is based upon outmoded aerodynamics concepts and the premise that mechanical flight must be unilateral, and that side forces can be ignored. The omnidirectional "AC plane" cannot exist due to basic assumptions of Aerodynamics!

It is time to re-educate and deviate from thinking that the thrust axis and vertical plane are the sole method of flight support. Aerodynamics, by the nature of the beast, *will not permit* static flight nor omnidirectional reaction; for only an inefficient "swimming" motion on a unilateral axis can result as long as mechanical objects are required to remain totally submerged in hypothetical "fluid."

AIRco has publicly charged falsification of data in the NACA RM L53A09 analysis of static-flight study of the Custer Channel Wing. It was never evaluated as the propulsion system which it truly is. and re-evaluation is being stressed.

As a result of that phase of the AIRco program. there are now persons running scared to evade detection of their intent at the time, but the fact remains that the blatant error sticks out like a sore thumb and nothing is being done about it!

To prove my point that aerodynamics needs reappraisal on its merit, I point out that a static object cannot have a torque moment and remain in static equilibrium. Therefore, I challenge anyone to zero recorded moments and forces as measured by NACA in the cursory testing of the channel principle, allegedly; for the report states that in static air condition there was *static lift* on a static vehicle! in aerodynamics, a condition such as this just is not permissable; but since the condition is both recorded and measured, there should be a modification of thinking in order to accept it—or error evidenced should be corrected!

The enormity of this principle, both for tactics and for commercial enterprise. will not be understood until human inertia is directed toward this advanced flight system. When we finally understand the omnidirectional induction of *power* forces. irrespective of *motion,* we'll have a broad new field for space flight design—who knows, we may even be able to accept. evaluate and analyze the non-existent UFO!

But, most assuredly, we can simplify flight and stay up out-of-the-mud in tactics.

Del Santee, Consultant
AIRco
Eau Gallie, Fla.

Extra Copies of NASA Issue Available

Additional copies of Missiles and Rockets' *Third Annual NASA Issue, which was first published Nov. 25, are still available.*

They may be ordered from:

Research Department
Missiles and Rockets
1001 Vermont Avenue, NW
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Price is $1.00 per copy. Payment must accompany the order.

18th Century Eruptions

To the Editor:

Relative to the note on p. 10 of the Dec. 9 issue concerning eruptions seen on the Moon, you may be interested in knowing that Sir William Herschel and friends observed an eruption on the Moon on May 4, 1783 (J. B. Sidgwick, "William Herschel. Explorer of the Heavens," Faber and Faber Ltd., London, pp. 96-97). Sidgwick adds, "Similar observations of bright spots on the dark side of the terminator have been made from time to time (among others. by Herschel himself in 1787) . . ."

E. Scott Barr
University, Ala.

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BOTH THE ADDRESS and the telephone numbers of the West Coast Editorial and Business Offices of Missiles and Rockets *have been changed to:*

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The Countdown

WASHINGTON

SRAM Possibility for Air Force's TFX

The Air Force is pressing work on its *SRAM* (*Short Range Attack Missile*) at Aeronautical Systems Division, Wright-Patterson AFB, Ohio. Studies of the system apparently are still largely in-house. It's believed *SRAM* could become a weapon for the Air Force version of the TFX aircraft.

Long Island Joins ERC Queue

Some 33 areas in 19 states are now vying for NASA's proposed $60-million Space Electronics Center. A Long Island delegation is the latest to visit space agency headquarters and present its case. The facility was originally planned for location in Boston, but Congress ruled that NASA would have to consider other sites.

Zeus Series Ends

The *Nike-Zeus* missile has undergone its final test firing at White Sands Missile Range, N.M., the Defense Dept. announced last week. Tests will continue at Kwajalein Island in the Pacific as part of the *Nike-X* program.

INDUSTRY

Breakthrough Achieved in Monolithic Circuits

Component isolation within an integrated circuit by a 1,000-v breakdown dielectric has been achieved by Signetics Corp., Sunnyvale, Calif. With this technique, microwatt circuits and speeds up to 100 mc become possible. Dr. B. David James, president for research, sees the process as "the most important thing since the advent of integrated circuits." Developed over the past two years from in-house funds, it eliminates use of reversed-bias p-n junctions for d-c isolation, cutting parasitic capacitance and leakage current by more than an order of magnitude. Devices already successfully integrated by present methods can still be used, including epitaxial devices, but previously unattainable configurations of p-n junctions in series of four or more can also be integrated. While giving no details of the process, James said that it meant a radical change in the fabrication and structure of monolithic circuits.

Aerojet Claims Mile-a-Second Fuel

Aerojet-General Corp. reports it has developed new solid rocket fuels that can get a missile a mile away from its launch site in one second after ignition. Extensive tests have established that the propellants, based on a combination of mechanical and chemical methods, have the fastest burning rate ever obtained in non-explosive solid fuels, according to the company's Solid Rocket Plant in Sacramento. Dr. Werner Kirschner, A-G vice president and manager of the plant, says the propellants are "safe, non-explosive formulas similar to the propellants of JATO rockets made by Aerojet and carried by thousands of aircraft for standby rocket power."

AMF Denies Group Shift

Senior officials of American Machine & Foundry Co. have denied a report that the company will move its Advanced Product Group from facilities in Greenwich and Stamford, Conn., to a newly acquired plant in York, Pa. (M/R, Dec. 16, p. 9). An AMF officer reports "there is presently no plan to change the status of the activities here. We have contractual obligations to do work here through '64 and possibly into '65." AMF will take over the $9.6-million York plant from the Navy on Feb. 1. The new plant will serve as a division of the Advanced Product Group, AMF says, and will be "augmented" with people from the other locations "as and when required." At the moment, AMF reports, "we have no indication how many people will be required."

FLOXed Atlas/Centaur for MOL?

A combination of a 'FLOXed' *Atlas* booster (M/R, Nov. 11, p. 14) and a *Centaur* second stage is being proposed by General Dynamics as a possible substitute for the *Titan III* booster planned for the Air Force's *Manned Orbiting Laboratory*. GD says it believes the combination could do the *MOL* job much cheaper.

SHIELD Against Missiles for Planes

Successful tests of a new electronic countermeasures device designed to protect bombers from both air-to-air and surface-to-air missiles have been reported by Sylvania Electric Products, Inc., a subsidiary of General Telephone and Electronics Corp. Called SHIELD (Sylvania High Intelligence Electronic Defense), the device is highly competent, a company spokesman says, and is expected to protect against radar-guided missiles.

TRW-Martin Computer Venture Weighed

Thompson Ramo Wooldridge Inc. and Martin Marietta Corp. are believed to be nearing a decision on joint formation of a new company in the computer field, reportedly with the aim of competing with IBM in the big-computer area. TRW has recently been stepping up promotion of its computer capability.

INTERNATIONAL

Blue Streak Moves Ahead . . .

Britain has successfully completed first static-firings at Woomera, Australia, of a *Blue Streak* rocket, planned first stage of the three-stage space booster for the European Launcher Development Organization (ELDO). Rocket actually tested was a dummy, which will now be removed from the stand. First live launching is scheduled for the early part of 1964.

. . . Along with Blue Steel

"The Daisy Cutter," an extremely low-altitude version of the British *Blue Steel* standoff bomb launched from manned aircraft, has passed flight tests at Woomera. RAF officers say they hope the weapon will be operational within two years, helping to fill the gap before *Polaris*-carrying ships are available to Britain.

Huge Soviet Satellite Predicted

This nation's world leadership in big boosters and largest satellite orbited, which should be established with next month's *SA-5 Saturn* launch, may be short-lived, says Wernher von Braun.

The director of the Marshall Space Flight Center looks for the Soviet Union to launch a satellite weighing between 40 and 50 tons "soon." He declined to be more specific in estimating when the Russian shot might take place.

Von Braun's remarks were made in New Orleans, where he accepted for NASA the first industry-built (Chrysler Corp.) *Saturn 1*. The booster will be used to launch boilerplate models of the North American Aviation *Apollo* command and service modules.

Marshall itself is prime contractor for the booster that will be used in *SA-5* to orbit a payload weighing 37,700 lbs. It will develop 1.5-million lbs.' thrust.

Von Braun said further that the Soviets are working on a huge new booster, which some experts have said will be in the 3-million-lb.-thrust class.

Shots of the Week

The Air Force on Dec. 18 launched three *Atlas* missiles from Vandenberg AFB—the first triple header of its kind.

All three launches—two of them ballistic shots at targets some 5,000 mi. downrange, and the other rocketing a secret satellite toward polar orbit—were reported to be apparently successful.

An *Advanced Ballistic Re-Entry System (ABRES)* vehicle was lofted aboard one of the *Atlases*.

- Two Air Force *Titan II* ICBM's were successfully launched Dec. 12 and 16, the first from Cape Kennedy, the other from Vandenberg AFB, Calif. The Cape Kennedy launch was to demonstrate repeatability of the accumulator installed in the missile's fuel line to overcome the so-called pogo effect, which constitutes a physical threat to *Gemini* astronauts. The missile was said to have flown a "perfect trajectory" of more than 5,000 mi., but success or failure of the accumulator—which did function satisfactorily in a Nov. 1 shot (see M/R, Nov. 11, p. 12)—was not revealed. The Vandenberg shot was a weapons test launched from a silo.
- *HYDAC*, a sounding rocket built by Douglas Aircraft and Lockheed was launched by the Navy from Pt. Arguello, Calif., Dec. 16.
- The Air Force successfully fired a *Minuteman* ICBM from Vandenberg AFB, Calif., Dec. 14.
- A *Minuteman* launched Dec. 18 from Cape Kennedy made a successful 5,000-mi. flight to the Ascension Island area. It carried a modified Wing II second stage with a thrust-vector-control system designed for use on the Wing VI *Minuteman*.
- The Army on Dec. 12 successfully test fired a *Nike-Zeus* from White Sands Missile Range, N.M.
- The Soviet Union launched a new Earth satellite, *Cosmos 23*, on Dec. 14.
- A Japanese-built *Lambda 2* rocket carried an instrument payload to an altitude of 376 mi. Dec. 12 from that country's new Kagoshima Space Center at the southern tip of Japan.

SA-5 Shot Postponed

The launch of *Saturn SA-5* was postponed from Dec. 18 to late January to permit replacement of several hundred stainless steel fittings that join segments of first-stage pneumatic lines.

Inspectors found cracks were appearing in the sleeves at a constantly increasing rate. Discovery of seven in one day precipitated postponement.

A NASA spokesman said the cracks resulted from "stress corrosion," a form of intergranular defect in the metal that appears after stress is applied. The stress came when the fittings were subjected to a pressure of 3,000 psi in pre-flight checkouts.

Extensive tests will be run to determine actual cause of the cracks.

Gyros Cause Tiros Slip

NASA plans to launch the *Tyros VIII* weather satellite Dec. 16 were continuing to slip last week, with Dec. 20 appearing as the earliest possible launch date.

Trouble with two gyroscopes in the *Delta* launch vehicle was blamed

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for the delay. One borderline gyroscope was rejected just prior to the original launch time and replaced, and a new date of the 17th was set.

In the course of replacing the faulty gyroscope, however, a second one exhibited excessive drift and the decision to slip the shot further was made.

The upcoming *Tiros* will be the first to use the Automatic Picture Transmission (APT) camera subsystem and the last of the standard configuration meteorological satellites to be launched before the "rolling wheel" and unusual orbit *Tiroses* are launched next year.

TRAP III Delivered to AF

An aircraft-borne system for measuring radiation involved in re-entry of high-speed bodies into the Earth's atmosphere has been delivered to the Air Force's Aeronautical Systems Division.

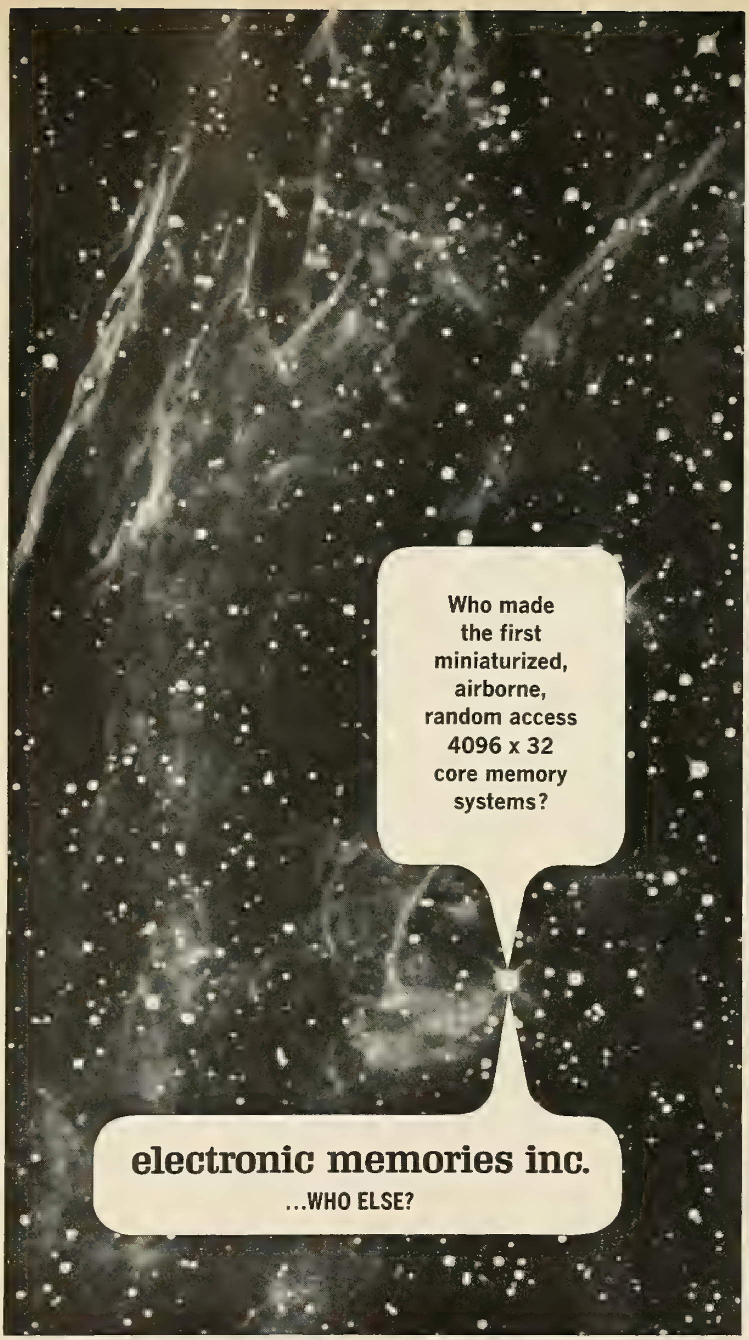
Called TRAP III (for Terminal Radiation Airborne Program), the system was designed by the Bendix Systems Division, Ann Arbor, Mich., for installation in a C-121 Super Constellation aircraft modified by Lockheed Aircraft Service Co. (see cover photo). Aerojet-General Corp. supplied optical instrumentation. Bendix provided integration, testing and evaluation, and assisted Air Force scientists in managing the program.

TRAP III is designed to permit scanning the skies from a single observation point. It is equipped with visual sighting stations and optical tracking, recording and timing equipment for measuring and recording re-entry phenomena.

Rover '65 Funding Debated

Next year's budget for Project *Rover* may be cut in half if President Johnson takes the advice of the Bureau of the Budget and Dr. Jerome B. Wiesner, the President's science advisor.

On the other hand, NASA and the Atomic Energy Commission, jointly responsible for development of the nuclear rocket, are telling the President that Project *Rover* must be maintained at a level of at least $200 million for Fiscal 1965 if the nation is not to lag in exploring space beyond the Moon. The two agencies waved aside Wiesner's and BOB's argument of "no requirement" for *Rover* by pointing out that the U.S. originally fell behind in the space race because there was "no requirement" for a high-thrust space booster in the pre-*Sputnik* days.



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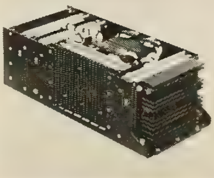

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Philco and STL . . .

Team Has Inside Track on MACS

by David C. Breasted

A TEAM of Philco and TRW-Space Technology Laboratories has its foot well in the door of the military *Medium Altitude Communications Satellite (MACS)* project with a significant extension of its study contract for program definition.

Defense Dept. spokesmen said last week that the 60-day extension does not mean that *MACS* has been approved for the development phase. But the extension was regarded as a firm indication that the team would probably gain design and production responsibility when DOD approves further steps.

One angle holding up the works, according to industry sources, is that Defense Secretary Robert S. McNamara, former president of Ford Motor Co., has taken extraordinary pains to see that no conflict-of-interest rumbles arise from the fact that Philco is a Ford subsidiary, even though Ford acquired Philco after McNamara took his present office.

Another factor is the continuing discussion between DOD and the civilian Communications Satellite Corp. on possible military uses of its Comsat.

However, it is understood that the reported decision to proceed further with a military Comsat was influenced by a DOD conclusion that the civilian satellite channels could not assure a satisfactory degree of communications security.

- **Narrowing down**—DOD last month allowed a second study contract, with a General Electric-Motorola team, to lapse after Air Force evaluation of both contracts concluded that Philco-TRW-STL was on a more acceptable track.

Funds for *MACS* are in the FY 1965 budget which has gone to the White House. About $110 million was appropriated for FY 1964, but only a small part of this has been committed because the project is still in definition phase.

The *MACS* plan is to place seven satellites in random polar orbits with a single launch vehicle in early 1965, a year later than originally planned. This would be the largest number orbited in a single launch. Ultimately, a total of 24 to 30 satellites would be placed in polar orbits ranging in altitude from 5,000 to 12,000 mi.

MACS has emerged from erratic military Comsat history which included the 1962 cancellation of the more ambitious *Advent* program after expenditure of about $170 million. *Advent* was to be a parking satellite orbiting at 22,300 mi. ■

Golovin Cites Hazards Of Reliability Methods

RELIABILITY and quality assurance programs too often become ritual "numbers rackets" at a time when the space effort faces future lifetime requirements thousands of times those of present ICBM systems.

This was one warning last week from Dr. Nicholas E. Golovin, of the Office of Science and Technology, in a speech to the National Press Club in Washington.

He said current methods associated with reliability and quality assurance have lost effectiveness, and sometimes end by lowering instead of increasing what he preferred to call "probability of mission success." He also warned that the same technological problems affecting the space effort are also contributing to serious deficiencies in major missile and ground and air-based military systems.

One prime reason for these headaches, he said, is that when budgets are reduced, "component and subsystem test programs are assigned the lowest priority, so they are often first to be cut."

By varied organizational tinkering, "systems analysis and quality assurance engineers are forced into subordinate relationships with designers and program directors so they cannot evaluate or even venture to criticize the efforts under way." The results of the ritual are frequently "deluges of very detailed, but mostly irrelevant, information," meaningless "qualified" components lists, and a general loss of faith in testing and quality assurance, Golovin said.

LBJ Reported Pressing For NATO Polaris Fleet

STOCK OF THE proposed NATO *Polaris* surface fleet rose appreciably last week with reports that President Lyndon B. Johnson intends to press the idea more vigorously in negotiations.

Detailed discussions among military representatives of the United States and six other NATO nations, together with ambassadorial talks, have made satisfying progress, according to Administration officials.

The Administration planned shortly to let key Congressmen in on the state of negotiations and consult with them on details.

While there were signs of optimism, nobody in Washington is inclined to bet his bottom dollar on the future of the multilateral force (MLF) because of continuing dissension in allied ranks.

Nonetheless, the United States is readying plans for a "demonstration" guided-missile destroyer to show that crews drawn from several nations can operate effectively together. Indications are that training of a mixed crew for the demonstration vessel will begin early in the coming year and last about six months.

Italy and Great Britain, which has been riding the fence on the project, reportedly will participate in operation of the destroyer, although this is not expected to constitute commitment to the organization.

At present, the United States, West Germany, Greece and Turkey are siding together firmly in favor of MLF. President Charles de Gaulle of France takes a dim view, a major pitfall in the project.

Webb sees 'fighting chance . . .'

NASA Struggling to Hold To 1970 Man-on-Moon Schedule

Administrator concedes loss of leeway; Administration denies Apollo will slip; Ranger program most affected by cutbacks

by Heather M. David

THE NATIONAL Aeronautics and pace Administration is still aiming for . manned lunar landing by 1970, but udget-knifers will make it a close shave.

"We still have a fighting chance to nake it in this decade, but we have lost ll our leeway," NASA administrator ames E. Webb told MISSILES AND OCKETS. The agency last week was till embroiled in budget decisions on iscal 1965 funds and whether or not o ask for a $250-million supplemental ppropriation for the remainder of Fisal 1964. Conferences are now at the residential level and a decision is exected imminently.

High Administration officials strongly eiterated their commitment to a lunar anding in this decade, and denied reurrent rumors that the program will lip into the early 1970's. In the face f sure Congressional budgetary resistnce, the agency internally began taking teps to strip all possible programs in rder to meet the *Apollo* goal.

• **Ranger hit**—NASA hopes to acrue a savings of $90 million by the ancellation of five *Ranger* lunar-impact pacecraft, which would have been desgnated flights 10 through 14. Dr. Homer . Newell, Associate Administrator for pace Science and Applications, anounced the decision last week.

The five *Rangers* would have been he first in which industry played a maor role in the program. The decision eaves *Ranger* solely in the lap of the riginal prime contractor, NASA's Jet ropulsion Laboratory, which also will ilot the current series of *Rangers*—6 hrough 9—scheduled for launch in 964.

Cancellation of the follow-on *Rangrs* came as a complete shock to conractor Northrop Corp., which had aleady completed evaluations of the *anger* design and made recommendaions for changes. Northrop had been rought into the *Ranger* program after ASA examined JPL's management and ermed it inadequate for the reliability and production standards required in the spaceflight program. All five *Rangers* which have been launched were failures.

A Northrop Corporation spokesman said that the company will now have to cut back its scientific and technical staff by about 800 persons. Approximately 900 had been engaged in the *Ranger* program.

While no hardware was involved in the actual Northrop contract, the company had already made commitments with a number of subcontractors. "It will be several weeks before the full extent of the cancellation can be determined," the Northrop spokesman said.

More Merritt RFP's Soon

REQUESTS FOR PROPOSALS for the launch operations contract for the Merritt Island Launch Area are expected to be issued shortly by NASA.

The space agency announced last week that Ling-Temco-Vought, Inc., will receive a cost-plus-incentive-fee contract for administrative and management services at the Moon launch center.

Proposals were received last week from 18 companies bidding on the base operations contract, described by one firm as worth about $10 million. They are: Republic Aviation; Westinghouse Electric; Marion Power Shovel; Michael Baker Jr., Inc.; Tumpane; Trans-World Airlines; Firestone Tire and Rubber Co.; Binnell Corp.

Also Hughes Aircraft; Hayes International; Federal Electric; Pan American; Lougee Co.; Allied-Vitro Corp.; Boeing-Morrison-Knudsen; Transport Co. of Texas; Management Services, Inc.; and Day & Zimmerman/Wellman-Lord Engineering, Inc.

Northrop has had a supporting role in the *Rangers* already launched, and will retain this relationship in the remaining four, Newell said. These spacecraft are to transmit high-resolution photographs of the Moon before hard-landing there. Two of the now-cancelled follow-on craft would have carried a survivable seismometer capsule similar to those flown in unsuccessful *Rangers* in 1962.

• **Emphasis shifts**—NASA now will rely more heavily on the *Surveyor* landing program and the *Lunar Orbiters* to pave the way for manned landings on the Moon.

Decision on the prime contractor for the *Lunar Orbiter* spacecraft is expected soon, although NASA has already asked industry for more extensive presentations of bids because of the program's newly increased status.

Five firms—Hughes Aircraft, the Boeing Co., Martin Marietta Corp., Lockheed Aircraft Corp., and Space Technology Laboratories, Inc.—have bid on the *Lunar Orbiter,* which will take intermittent photographs of the lunar square at a high resolution, perhaps one meter.

• **Apollo cutbacks**—NASA earlier sent telegrams advising Project *Apollo* contractors to freeze employment levels and not fill vacancies as they occur. Ten top companies and the Massachusetts Institute of Technology received orders at least until final reprogramming of NASA's funds for this year.

Earlier this fall the agency cut out six *Saturn 1 Apollo* flights in an effort to save $50 million in FY 1964 funds.

• **Nuclear rocket**—NASA has decided against initiating postponement of its nuclear rocket program, in spite of advice to cut it by Dr. Jerome Wiesner, Presidential science advisor, and Budget Bureau members. NASA and the AEC contend that it is the only promising propulsion system for long-range programs (See p. 13). ■

Arms controls likely . . .

DOD Official Urges Industry To Consider Non-Defense Markets

Deputy Assistant Secretary Barber says some will be hurt but there's no need to panic; government to ease changeover

by Russell Hawkes

THE DEFENSE INDUSTRY would be wise to seek non-defense markets as a hedge against declining defense budgets resulting from arms control agreements, which look increasingly probable in 1964.

This was the advice offered in a Los Angeles speech to the American Institute of Aeronautics and Astronautics by Arthur Barber, Deputy Assistant Secretary of Defense for Arms Control. Barber also predicted steps that the Government will take to ease the transition for defense contractors.

He estimated that there is a better than even chance of some sort of East-West arms control agreement with mutual inspection provisions during the next 12 months. He expects visible progress toward this when negotiations between the U.S. and Russia reopen in January.

"There is no sure way to predict the turns of Soviet policy," Barber warned, "but we shouldn't underestimate the economic squeeze they are in. They want settlements, they want to negotiate."

If an arms control agreement should be reached in 1964, it probably will have limited aims. Barber cautioned the industry audience that general and complete disarmament does stand as an objective of U.S. foreign policy, and industry would be foolish to ignore it. However, "separate measures" intended to reduce the risk of war in Europe and elsewhere are more likely while major issues between the U.S. and the Soviet Union remain unresolved. The joint U.S.-USSR proposal on the peaceful uses of space (M/R, Dec. 2, p. 17) now before the United Nations could fall in this category.

Barber emphasized that if there is any arms control agreement based on inspection, the inspectors will be supplied by the U.S. and Russia, not by the UN.

- **The pressures**—Economic goals of the government and the approaching completion of U.S. strategic missile inventories tend to reinforce the downward pressures upon defense contracting caused by easing of East-West tensions. Congress has stressed that the Johnson Administration cannot have the tax cut it wants unless the Federal budget is cut. Therefore, the time between now and the budget's submission on Jan. 20 is apt to see more programs go the way of *Dyna-Soar*.

"What you've got to face is that the markets you're in are going to diminish and you've got to create new products," Barber insisted.

He told MISSILES AND ROCKETS that he believes Soviet defense industry has less of the elasticity needed to cope with arms control than does the U.S. industry. "The Russian industry is bureaucratically all fouled up," Barber said.

He identified the new trend toward East-West negotiation and reduced defense contracting as "the third basic shift in defense strategy in the past 13 years." The first was the Korean War expansion, he noted, and the second was the shift to ballistic missiles.

Barber describes the new shift by listing the major elements of U.S. defense policy. One of the elements is that the United States is now prepared to negotiate with its opponents. Another is that the only purpose of the defense establishment is to serve as an instrument of U.S. foreign policy. Now is the time, said Barber, for government and industry leaders to discuss ways of eas-

Johnson Space Views Described

"Contrary to some published reports, President Johnson is not predisposed to a military emphasis on space," a legislative official intimately familiar with Johnson's space policies has told MISSILES AND ROCKETS.

"He will judge the requirements of DOD and NASA strictly on merit, if his past performance is any measure," continued Dr. Glen Wilson, a long-time professional staff member of the Senate Space Committee, which Johnson headed from its inception until he became Vice President.

Wilson said that possibly Johnson's strong identification with military space stems from his military record, which goes back to 1937 when he was placed on the House Naval Affairs Committee, later absorbed into the House Armed Services Committee. Then, in 1949, when he entered the Senate, he went on the Armed Services Committee there and a year later was made chairman of its Preparedness Investigating Subcommittee.

"Nevertheless, it must be remembered," Wilson stressed, "that Johnson was one of the few men on the Hill to recognize the supreme importance of the *Sputnik I* launch, and he instigated an extraordinary session of Senate hearings a few weeks later."

Wilson also noted that Johnson sparked the civilian space program when he introduced a resolution to create the Senate Space Committee, even though he could have recommended putting it under his Preparedness Subcommittee. The first legislative act of this space committee was to look into and approve the creation of the National Aeronautics and Space Administration.

ing the transition from one cycle of defense spending to the next with minimum disturbance to the economy, the industry and the individuals involved.

As a first step in that direction, the Defense Dept. is collecting information on the composition of the industry. A special annual survey of defense manufacturers conducted by the Bureau of the Census as a supplement to the 1963 annual survey of manufacturers is supposed to include detailed procurement data on Defense Dept., NASA and Atomic Energy Commission programs.

Barber said, "While we know our prime contractors, we have little or no data on second-, third- or fourth-tier subcontractors." The new survey will find where work is located, the value of sales to the Defense Dept., and the proportion of contractors' employees doing defense work.

- **No reason to panic**—Barber deprecated the economic repercussions of a cut in defense contracting. He pointed out that the money spent on defense is only about 2.5% of the gross national product, so a 10% cut in defense spending during the next few years would be negligible in its effects on the economy as a whole. "It is going to hurt some people, I don't mean to say it won't," the Pentagon official said, "but even in terms of the defense industry, it isn't disaster by a long shot and we shouldn't get a panic view of this."

"Production of tanks, conventional ordnance, and other Army-Navy material dropped from $11 billion per year in 1953 to about $2 billion per year in 1957. That is a cut of about 85% in four years. The result was a major loss of defense business in the Middle West, where such production had been concentrated. The fact that few people today are aware of this $9-billion shift indicates how readily a dynamic economy can adapt to such a change."

- **Little nourishment in inspection**—Barber warned the missile/space industry not to expect arms control to generate a big market for their capabilities which might partially replace the defense market. He said, "I don't believe aerospace and electronics companies are going to find a very great procurement market out of so-called inspection technology. I've looked at the costs of some of the proposed inspection systems and they run between $10 million and $20 million, 90% of which is off-the-shelf equipment." Many existing military systems can be used for inspection with little or no alteration.

Instead, Barber recommended that defense contractors diversify their product lines to get into new markets or else find civilian markets for their present product line.

"I'm personally convinced that five years from now some of you are going to make real good profits on products that you don't presently have in preliminary design," he told the contractor officials, "but I'm equally convinced that some other companies are going to have a real hard time."

Barber believes that Government funds will be used increasingly to bring advanced technology and perhaps other attributes of the missile/space industry into the civilian economy. He cited air pollution, water purification, education and other areas where such a thing may prove to be possible. He conceded that this idea has been discussed in the past, but always came to nought when the subject of funds was raised. "However, I feel . . . that his pattern may change rather sharply in the next two years."

5-Year Force Structure To Be Industry Guide

THE DEFENSE DEPT. intends to translate its "five-year force structure" prediction of the changing character of the defense establishment into economic guidelines for industry.

The office of DOD Controller Charles Hitch and the Institute for Defense Analysis are jointly devising the method of accomplishing the translation and probably will announce it in 12 to 18 months, says Deputy Assistant Secretary of Defense (Arms Control) Arthur Barber.

It is expected to take the form of an annual five-year forecast of Defense Dept. needs in everything from missiles to potatoes. It probably will be coordinated every year with the presentation to Congress of the DOD budget. Each year's forecast would modify that of the preceding year to reflect changes in public policy and developments in technology.

In the few years since its conception, the five-year force structure has been a top-secret document never distributed outside the Pentagon; outsiders have never had an opportunity to debate its accuracy and value. Barber told MISSILES AND ROCKETS that it has proven quite accurate, with errors typically about 2-3%. Some other qualified observers say that estimate is far too low, and any quantitative assessment should be viewed with suspicion.

In answer to a question, he acknowledged that the profit margin in the aerospace business has been too small in recent years to permit serious development with private funds.

- **Federal help**—Sen. Philip A. Hart (D-Mich.) has proposed establishment of a commission to apply technology to community needs and social goals. The question to be debated is whether the government is entitled to use its power for this purpose. There is no doubt that the Federal Government has the means of creating markets. The decision must be made by the Congress and the people, Barber said. He predicted that Hart's proposed commission or one like it will be created within the next few months.

An official of one company expressed doubt that companies which have labored for years under Defense Dept. rules on new product development still have the flexibility to shift into new fields. Barber conceded that "I think we've got to stop tying you up in knots through contractual procedures. . . . We want to release you so the contracting officer isn't doing your management job." However, "it is difficult to change the system."

The Dept. of Defense is studying possible changes to the Armed Services Procurement Regulations (ASPR) with the goal of giving the defense industry more freedom to find new markets. At present, if a company spends its own money to develop a civilian market for a product originally conceived under a defense contract, the profits on the product can be renegotiated away. Revisions to the ASPR may change this.

The ways in which DOD administers its policies will also be intended to ease the transition, according to Barber. For instance, security restrictions in many cases prevent the sale of items developed for defense to civilians or to foreign countries. "At Office of the Secretary of Defense level," Barber said, "we would be most willing to go back and review security restrictions—particularly, say, at the 'confidential' level. If a company estimates there is a sizeable market for an item, we can declassify it. I won't say we definitely will declassify it, but in view of the national interest in balance of payments and stimulating foreign trade, we would be willing to review classifications. I know of cases in the past two weeks where we have made precisely that determination—making it possible for companies to make foreign sales."

Barber suggested that the management skills that the missile/space industry has collected might be turned to the management of large-scale public programs that are not primarily technological. The management of foreign aid programs under contract might be one possibility. Barber said that the idea arises from the fact that the personnel files of the aerospace industry show that the largest percentage growth is not in the ranks of the professional technologists, but in the non-technological professions, such as economics, law and accountancy. ■

Interest Grows in New Echo II Pyrazole Controlled-Inflation Scheme

by Michael Getler

SUCCESSFUL in-flight deployment of the next *Echo II* passive communications satellite using a new controlled-inflation system could pave the way to a much wider range of applications for inflatable structures.

There has been a continuing NASA interest in inflatable devices, not only for comsat use but as a possible means to deploy very large spaceborne antennas without crippling weight penalties and also as a means to erect various multiple-form space platforms.

Though the *Echo II* inflation system development has been in the hands of the Goddard Space Flight Center's passive comsat group, other project groups within the space agency are known to be following the development closely.

The new system is credited to NASA's John Thole, spacecraft systems manager at Goddard, with development work performed by the Geophysics Corp. of America's Viron Div. in Anoka, Minn.

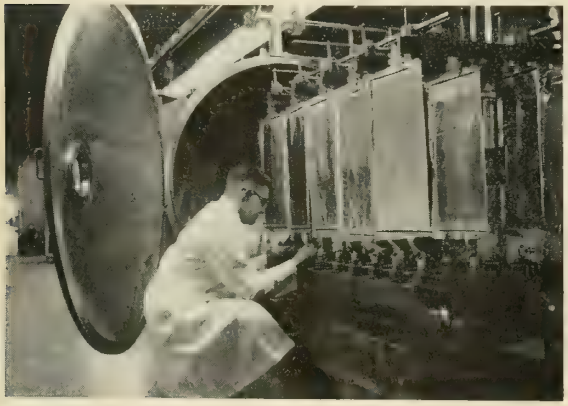
- **Design details**—According to Leroy A. Bushay, program manager at Viron, the *Echo II* inflation system is made up of 72 thinly folded and specially treated plastic bags that contain a total of 5,184 small packaged wafers of pyrazole, a white crystalline substance that vaporizes when exposed to solar radiation in space.

These bags are attached on one side to the inside skin of the balloon in a definite pattern inside the folds of the satellite as it is packed before installation in the canister that carries it into orbit.

Once ejected from the canister in space, residual air remaining in small quantity within the satellite skin after packaging deploys the balloon in a matter of seconds to a "round, soft ball" shape.

As the balloon deploys, solar heat first melts a black wax sealant on the outer edge of each bag. The wax will melt at about 37°C. This causes the bag to expand and unfold inside the sphere, exposing thousands of small perforated holes on the inner fold surfaces from which the pyrazole, as it in turn vaporizes due to solar heating, can escape to fill the sphere. The positioning of these bags within the satellite provides for a gradual pressure build-up during inflation.

NASA engineers say that with this system, the 135-ft.-dia. *Echo II* satellite will take about 90 minutes to come to full pressure. With this type of slower, more controlled inflation scheme, NASA engineers told MISSILES AND ROCKETS that the satellite will be able to go to much higher pressures than were previously obtainable (enhancing both the structural integrity and the RF reflectivity). It will also be able to maintain at least 90% of full pressure for about 10 hours.



FINISHED BAGS are out-gassed of any water vapor in a GCA-designed vacuum chamber at pressures of 10^{-8} torr. Slow diffusion process in chamber can take up to 48 hours.

Though the use of pyrazole enables *Echo II* designers to go to the higher pressures, NASA engineers point out that it is the new packaging scheme and not merely the use of pyrazole that is so auspicious for inflatable structures programs. Actually, chemicals other than pyrazole will be required for different pressures required by other inflatable structure concepts.

It is now expected that *Echo II* will be launched from the Pacific Missile Range by a *Thor-Agena B* vehicle into a highly inclined, 700-n-mi. orbit "early in the first quarter of next year," according to NASA. The shot was originally planned to take place late this year.

- **Testing schedule**—A test and engineering program on the inflation system has already been completed at Goddard. Other tests of satellite skin integrity and deployment were slated at Lakehurst, N.J., and at Goddard late last week. At Lakehurst, inflation tests using only helium were planned.

At Goddard, drop tests were slated in the large vacuum chamber in which an *Echo II* canister, with balloon and inflation system packed inside, would be exploded while in free-fall to check initial deployment phase.

In earlier ballistic tests (AVT's or Applications Vertical Tests) of *Echo II* balloons, engineers used acetamide (in the first test) and benzoic acid (in the second test) as sublimating powders dusted in the longitudinal folds of the deflated satellite.

With these systems, the balloon experiences a very rapid increase in pressure that NASA engineers say results in a "flash acceleration of the skin." This method overstressed the skin in a few seconds after deployment in the first AVT last January.

NASA awarded the G.T. Schjeldahl Co. of Northfield, Minn., a $362,000 contract this summer to build three of the *Echo II* balloons. The balloons are actually a laminate of two layers of 0.18-mil aluminum foil surrounding a 0.35-mil sheet of mylar plastic (M/R, May 28 '62, p. 18). ■

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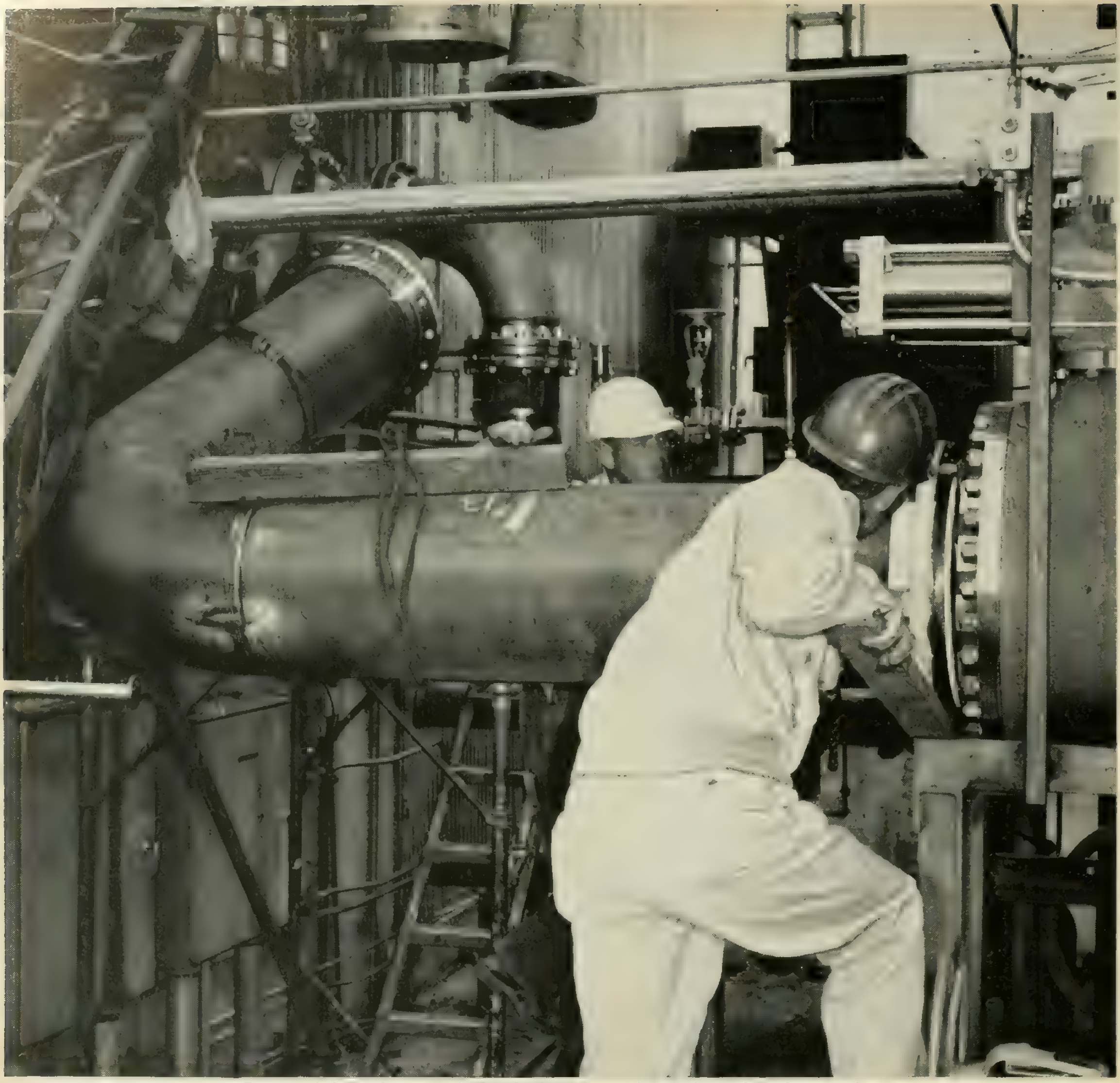

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PROPULSION

Rocket Research Gets Tripropellant Patents

Two patents, covering the tripropellant combinations beryllium-oxygen-hydrogen and lithium-fluorine-hydrogen, have been issued to Robert M. Bridgeforth and assigned to Rocket Research Corp., Seattle. Both approaches to these ultra-high-specific-impulse stable propellants use hydrogen as the working fluid rather than as a fuel. The beryllium-oxygen or lithium-fluorine systems provide heat for the hydrogen, which then expands through a nozzle producing thrust. The propellant systems operate at high performance levels with very low exhaust gas temperatures. This makes possible the launching of a rocket which would be invisible or just barely noticeable from the standpoint of thermal radiation. The beryllium patent is U.S. Patent 3,112,609 and the lithium is covered in U.S. Patent 3,112,608.

MATERIALS

Novel Thin Film Measurement Perfected

A new phenomenon manifested as a structure in the scattered radiation accompanying a specularly reflected X-ray beam is the basis of a method of determining the thicknesses of extremely thin films. Professor Nathan Wainfan of the Polytechnic Institute of Brooklyn attributes the phenomenon to an interference between the components of scattered radiation originating at two surfaces of the thin film. This interference structure in the scattered radiation has been analyzed and used to determine the thickness of vacuum-deposited films ranging in depth from 250 to 1,000 Å. The results were consistent with other measuring techniques.

New Zirconia Fibers Out of H.I. Thompson

Four new high-temperature-resistant zirconia-type fibers are available from H.I. Thompson Fiber Glass Co. The fibers can be molded through conventional processes to withstand temperatures up to 4,000°F in ablative and insulative components. The fibers can be used as reinforcements in composites. In recent lab tests, drawn monofilament zirconia exhibited breaking strengths between 200,000 and 500,000 psi.

Graphite/Cast Iron Sintered Bearing Perfected

United States Graphite Co. is marketing a new powder metallurgy alloy similar in structure and chemistry to cast iron but with an extremely low coefficient of friction. The GRAMIX Grade 548 is basically ferritic iron containing unalloyed graphite particles. With a porosity rating of 29% by volume, the bearing material provides a high oil capacity and accurate sizing by repressing. A typical 0.5-in. bore can be held to a total tolerance of 0.0003 in. Grade 548 has a radial crushing strength of 9,000 psi, a tensile strength of 4,500 psi and a yield point in compression of 3,000 psi. Dry density range is 5.4 to 5.8 g/cc.

ELECTRONICS

Greenbank To Use Mm-band Antenna

A 12-ft.-dia. spun-cast paraboloidal-reflector antenna, built by Electronic Specialty Co., will be used by the National Radio Astronomy Observatory at Greenbank, West Virginia, for radio telescope studies in the millimeter waveband region. Touted as one of the most accurate antennas of its kind ever produced, it was fabricated by pouring thermo-setting plastic into a spinning metal support dish and allowing it to harden before stopping the "mold" rotation, thus forming a nearly perfect paraboloid. Only the addition of a mirror surface was required to complete the structure, the company said.

R&RR Performance Exceeds Predictions

During tracking of the *IMP* satellite, mobile Goddard range and range rate equipment at Scottsdale, Ariz., reportedly has performed about twice as well as was expected. Variation about the mean range reading has been approximately ±15 meters. Double this variation was expected by the Military Electronics Div. of Motorola Inc., makers of the equipment, because of the low power (200 mw) of the *IMP* VHF transponder. The R&RR system was designed for use at S-band with an 800-mw transponder. Differences between orbital predictions and measured range, however, have not been as good. Whether this is the fault of the orbital equations or the measuring equipment is not clear. The other two stations of the Goddard network—at Rosman, N.C., and Carnarvon, Australia—are expected to be operational in February. Final destination of the mobile station may be Madagascar.

NATO Communications System Operational

With acceptance of the last of 82 stations by Supreme Headquarters Allied Powers Europe recently, the 8,300-mile-long ACE HIGH telecommunications system was declared operational. The system includes over 7,000 miles of tropospheric-scatter links, according to Radio Engineering Laboratories, Inc., which supplied 10-kw tropo radio equipment for over 40 of the terminals. A 60-voice channel capacity is provided in the scatter portion of the network.

SPACE MEDICINE

Barriers Block Life on Mars

Not only do the Sun's lethal ultraviolet rays penetrate to the surface of Mars, but the rays interact with the small amount of oxygen present to form a thin, corrosive smog of ozone—posing a double threat to life. Dr. Fred F. Marmo, director of the Space Sciences Lab at Geophysics Corp. of America, drew this conclusion after more than four years of study using advanced photochemical equipment under NASA contracts. The experiment involved simulation of known Martian atmosphere constituents with ultraviolet light interaction. Marmo said the amount of oxygen on Mars is too minute to be seen from the Earth, but experiments indicate enough is present to produce ozone and that this gas is generated right down to the surface of the planet.

N_2/O_2 Auto Control Unit Tested

The Air Force has tested an automatic nitrogen and oxygen indicator-controller assembly that could be used in manned spacecraft. The device, developed by Northrop Space Laboratories, was operated continuously for three days in a two-man test at the Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio. A sea-level pressure and atmospheric mixture of oxygen and nitrogen was maintained successfully.

Silicon-Boron Shielding Protects ASSET Vehicle During Re-entry

McDonnell-developed craft is coated with Chromalloy Corp.'s W-3 to withstand Mach 18 speeds generating temperatures of several thousand degrees; program expansion to follow X-20 cancellation

by John F. Judge

A PROPRIETARY silicon-boron coating perfected by Chromalloy Corp., West Nyack, N.Y., shields structural parts of the Air Force's *ASSET* test vehicles during re-entry experiments.

The $34-million *ASSET* (Aerothermodynamic/elastic Structural Systems Environmental Tests) program still has five more launches to go after the successful shot last Sept. 18. That vehicle was not recovered. The program is to be extended due to the *Dyna-Soar* cancellation.

The program is designed to check out the glide method of re-entry and to test materials and designs that may become part of the *Aerospace Plane*. McDonnell Aircraft supplies the *ASSET* vehicles under an Air Force contract.

Because certain segments of the *ASSET* structure (nose skirt, underbody panels, pressure fittings and tubing) are subject to extremely high temperatures and stresses, many ground tests were conducted to substantiate the effectiveness of a specially coated molybdenum alloy.

The projected flight plan calls for the *ASSET* vehicles to start their glide paths to Earth from a maximum of 230,000 ft. at approximately Mach 18, so that environmental temperatures of several thousand degrees are expected. Ground tests indicate that treating the molybdenum alloys with a W-3 coating developed by Chromalloy Corp., should help the *ASSET* vehicle to pass through the re-entry phase without serious damage.

- **Realistic tests**—The TZM molybdenum with 0.5% titanium plus a trace of zirconium was used in a variety of sizes and shapes to simulate actual parts of the *ASSET* structure. Components tested included corrugated panels drilled to receive rivets and mounted components, pressure fittings, tubing and various drilled and countersunk speciments of TZM. Tests were conducted at many different temperatures, and the results were evaluated on the basis of surface and sub-surface conditions shown by metallographic examination.

W-3 chromallized parts maintained dimensional stability and coating thickness throughout all operations. Coating integrity on tubular parts was satisfactory on both interior and exterior surfaces, and drilled sections maintained uniform coating thickness. TZM specimens tested at high temperature showed tensile strengths above guaranteed minimums, based on original (uncoated) dimensions and acceptable elongation.

By testing extensively before actual *ASSET* flights, important and conclusive information was made available at an earlier date, vehicle structural safety was assured, and the cost of compiling such data in flight was obviated.

While available telemetry data are valuable, information also depends upon post-flight physical examination of the vehicles themselves. Loss of the first *ASSET* on its Sept. 18 flight is a case in point. All the information obtained was collected by test results in pre-flight operations, together with telemetry reports during the 1,000-mi.-long, 35-mi.-high flight.

- **Mils for inches**—Because the W-3 diffusion coating makes molybdenum resist oxidation at high temperatures, it eliminates the need for heavy or expensive insulation, ablation protection, cooling systems, or heat sinks. The coating forms an integral part of the structure; it does not spall, crack or flake off.

Riveting of molybdenum sections is required because structurally adequate welds cannot be produced. Oxidation protection is also improved. Rivets are formed for McDonnell from refractory metal rods.

When sub and major assemblies are coated, the W-3 process is repeated. First, the basic details are coated, then assembled onto panels or other structures. After assembly a second coating is applied to rivet tails and other areas where the coating may have been damaged during fabrication.

Because of the large grain size of TZM, annealing makes it brittle, creating problems in machining and assembly. Cold-working the alloy breaks down large grains and imparts greater strength to the material. A number of passes may be required and contribute stresses to the metal that subsequently must be relieved.

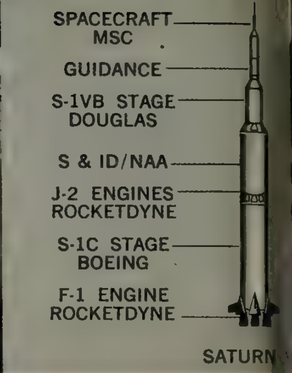
While structurally an excellent ma-

Circle No. 6 on Subscriber Service Card—

Charlie Geisewite speaks with authority on aluminum metallurgy

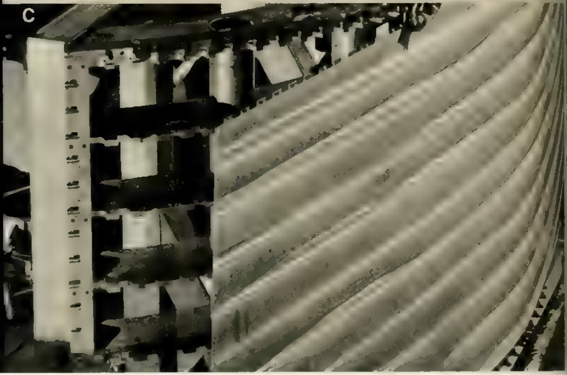
This man's aluminum is going to the moon

ALCOA



(A) Aluminum billets 5½ in. thick, 27 in. wide, 37 ft long and weighing 5,400 lb are produced by Alcoa for the Saturn V first-stage booster "Y" rings. They're shown here at Alcoa's Davenport Works awaiting submersion in the ultrasonic testing tank. (B) Billet after rolling to a 16½-ft radius. 70 per cent of the metal will be machined away to form a "Y" shape. The piece will then become one third of the Saturn S-1C "Y" ring. (C) Cylindrical portions of fuel and LOX tanks for Saturn V flight boosters are fabricated from 2219 plate furnished by Alcoa 11 ft wide, 27 ft long and 2¼ in. thick. The plate is shown after machining being mounted by Boeing technicians on a fixture prior to the age-forming process. Boeing eliminated costly labor and tooling processes by forming the plates at the same time the material is aged in an electric air-recirculating furnace.

Charlie Geisewite speaks with authority on aluminum metallurgy



Some bright morning, probably within the next six years, the three-man Apollo spacecraft will be launched by the Saturn V rocket into orbit around the moon. Then the two-man lunar excursion module will be dispatched for the actual moon landing. A unique high-strength aluminum alloy, developed by Alcoa, has been assigned a critical function in getting us there.

This relatively new alloy, designated 2219, has been selected as the major structural material for the Apollo booster because it alone provides the required combination of high strength, light weight, resistance to stress-corrosion cracking, good weldability and a high degree of both uniformity and reliability of weld strength. Nearly 33,000 in. of welding are required for the S-1C, the booster stage of the Saturn/Apollo vehicle which has a diameter of 33 ft and stands 138 ft high.

The Boeing Company has a contract with the National Aeronautics and Space Administration, Marshall Space Flight Center, to produce nine S-1C flight boosters and one ground test version. Alcoa will supply approximately 400,000 lb of 2219 alloy for the fuel and liquid oxygen tanks in each booster. Cylindrical portions of both tanks will be fabricated of plate 11 ft wide and 26 ft long. Four sections will be joined by welding to form a hoop more than 100 ft in circumference. Sidewall for the 44-ft-long fuel tank will be made by stacking two hoops and welding them together. Four such hoops will form the walls of the 64-ft-long liquid oxygen tank. Two domed ends for each tank will be fabricated by using 2219 plate sections.

Of particular interest are the "Y" rings, an integral part of the fuel tank and outer structure. For these, Alcoa supplies 2219 aluminum alloy in the form of 5,400-lb billets.

[illegible] plate and billets must be ultrasonically clean and delivered [illegible] A ultrasonic condition. The man responsible for the critical quality control that makes this possible in these unusually large sizes is C. F. Geisewite, Chief Metallurgist at Alcoa's Davenport, Iowa, Works, where Alcoa® Alloy 2219 for Saturn is rolled. Charlie Geisewite is a veteran of 35 years with Alcoa—and a veteran in working with customers in the aerospace industry. He's worked in the metallurgy departments of practically all of our plants on both development and quality control problems, has been associated with some of the pioneering achievements in the history of flight.

When we opened the Davenport plant in 1948—from the beginning it has been the world's largest aluminum rolling mill—Charlie was the obvious choice to head up its metallurgy. Since then he has trained dozens of young men who have made a name for themselves in advancing the art and now serve Alcoa customers throughout the world.

When you have a problem that a knowledgeable use of metals might solve, it pays to deal with the supplier offering the greatest depth in experience, research and technical assistance. In the case of aluminum, that supplier is Alcoa. Just call the local Alcoa sales office, your liaison with technical people like Charlie Geisewite. Or write Aluminum Company of America, 1872-M Alcoa Building, Pittsburgh, Pa., 15219.

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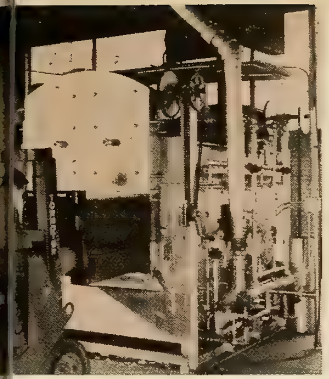
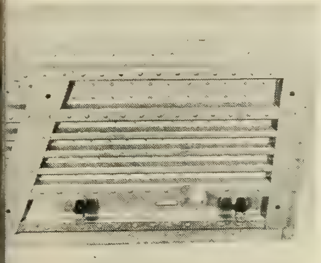
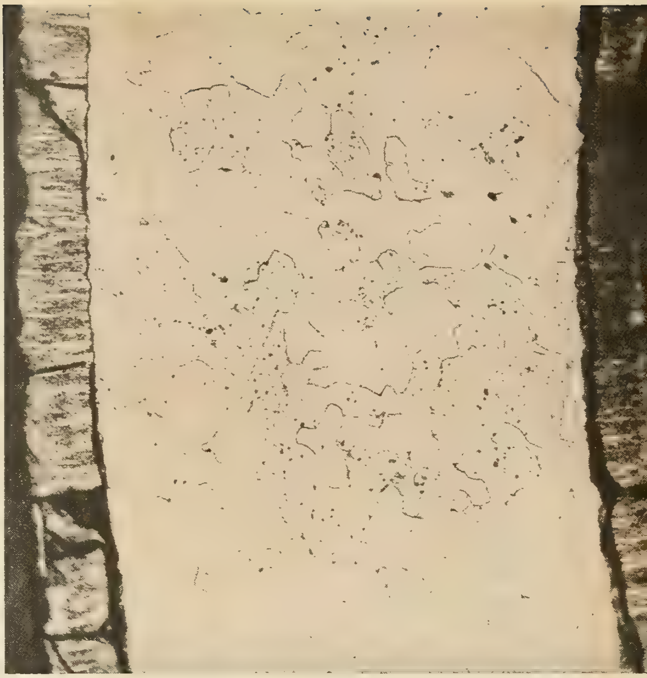
ALCOA







ABOVE LEFT: A component moves into chromallizing kiln. LEFT: A single-faced TZM molybdenum alloy panel with W-3 coating. ABOVE: Coated TZM tubing and (right) a section through tubing showing uniformity of the 2 to 2.5-mil coating.

terial, TZM is subject to oxidation. Uncoated, it will oxidize slowly at around 900° F. The oxide volatilizes at 1,200 to 1,300° F, and at 2,500° F the metal disintegrates within a few seconds. However, after application of the W-3 coating, the same material will withstand at least two hours of exposure at 3,100° F, without weight loss or oxidiation, making the coating TZM ideal for aerospace use.

The coating can be applied without causing recrystallization, and metallographic examination confirms the diffusion bond between coating and basis metal.

Chromallizing is a practical production method of applying a uniform diffusion coating to complex structural parts. Various compositions are available, the principal components of the W-3 coating being silicon and boron.

- **Coating the parts**—During the pack cementation process, components to be coated are embedded in and completely surrounded by the finely divided compound, and sealed in a retort. The compound includes the metallic elements which diffuse into the base metal, as well as a gaseous material to act as a transfer medium. Because both the gas and the metallic powders penetrate into small holes and cavities, excellent surface protection of even complex shapes is readily possible.

Detail parts affixed to a large single-faced corrugated panel were protected with the W-3 coating, then oxidation-tested to 2,000° F three times for 30 minutes each. Next, parts were re-coated and assembled to check hole alignment. All dimensions were maintained with coating uniform throughout the tests.

A pressure fitting made of TZM molybdenum alloy, with a tube length of approximately three inches, and an inside diameter of ⅛ inch, was coated with W-3. Metallographic sections were subsequently prepared to check the distribution and thickness of the coating. Both interior and exterior surfaces were satisfactory, thickness coating varying from 1.5 to 2.0 mils. Another test to determine coating in and around rivet holes and countersinks showed that hole sides maintained uniform coating thickness of between 0.0005 and 0.0007 in.

Because tubing is used in many cases for the pressure-measuring systems in the *ASSET* vehicle, a seven-inch-long tube section with a ⅛-in. diameter was formed with two right-angle bends. The tubing was coated inside and out with the W-3 process. Metallographic sections showed coating thickness and integrity satisfactory on both surfaces.

- **Strength preserved**—Tensile strengths were checked at room and at elevated temperatures (maximum 3,000° F) on 20 coated and 4 uncoated TZM specimens. No adverse effects were incurred on the coated specimens beyond a slight dimensional change caused by the coating process. Standard strengths remained within limits.

Uncoated specimens, tested at room temperature, showed 7 to 9% elongation. Protected with a W-3 silicide coating, oxidation-checked at 2,000° F and then re-coated, elongation values at room temperature remained essentially the same.

As test temperatures for the double-coated specimens were increased, elongation decreased, reaching 1% at 1,800° F. With still higher temperatures, elongation tests were no longer feasible. After the test bar ruptured, oxidation of the broken (uncoated) ends was so severe that they could no longer be fitted together for meaningful elongation measurement.

A typical *ASSET* flight is expected to last about 17 minutes. A W-3 chromallized lower body panel performed satisfactorily while exposed to the time temperature history of a flight, simulated in a quartz-lamp heating facility.

McDonnell is continuing the program of applied research on materials such as refractory metals, refractory ceramics and super alloys to arrive at optimum configurations of the *ASSET* structure. Each vehicle will form a test bed for further research on structures, aerodynamics, thermodynamics and thermoelasticity.

The relatively low-cost, short-term *ASSET* program may have a follow-on potential to yield results in improved space communications, propulsion, observation and navigation. ■

—Circle No. 6 on Subscriber Service Card

Aerospace Corp. Steerable Antenna Seeking Accuracy of 20 Arc Seconds

New facility should be ready for use during Dec. 30 lunar eclipse; active radar work due within year; millimeter research effort planned

by Rex Pay

El Segundo, Calif.—One of the world's most accurate steerable antennas—a 15-ft.-dia. Cassegrainian—is nearing completion at Aerospace Corporation. Overall system pointing accuracy is a guaranteed 30 arc seconds, but developers claim that 20-arc-seconds accuracy is expected.

When operating at 1 mm, the antenna has an electrical aperture (diamameter-wavelength ratio) of 4,600:1. Beamwidth at 240 gc is 1.2 arc minutes; gain is 78 db. Possible operating frequencies extend from 35 to 300 gc.

A real-time digital servo system points the antenna. Tracking rates can be adjusted from 0.001 degree per sec. (a quarter of sideral rate) to 3 degrees per sec. (low-altitude satellite rate).

At low satellite altitudes (100 mi.), the center of the beam can be pointed to within 52 ft. of a target object, the beamwidth being 500 ft. at this range.

Aerospace hopes to have the new facility in full operation during the lunar eclipse on Dec. 30. Active radar operation is expected in a year's time. At present, the digital control system does not have the capability to track millimeter sources by reference to incoming signal strength.

- **Early plans**—The antenna will be used initially for passive measurements of lunar and solar surface characteristics, atmospheric absorption, and stellar sources of millimeter waves.

At 94 gc, the initial operating frequency of the antenna, the Moon is about 10 beamwidths wide, and coarse lunar mapping can be carried out. At higher frequencies, and with improved techniques, Aerospace scientists hope to examine millimeter emission from individual lunar craters.

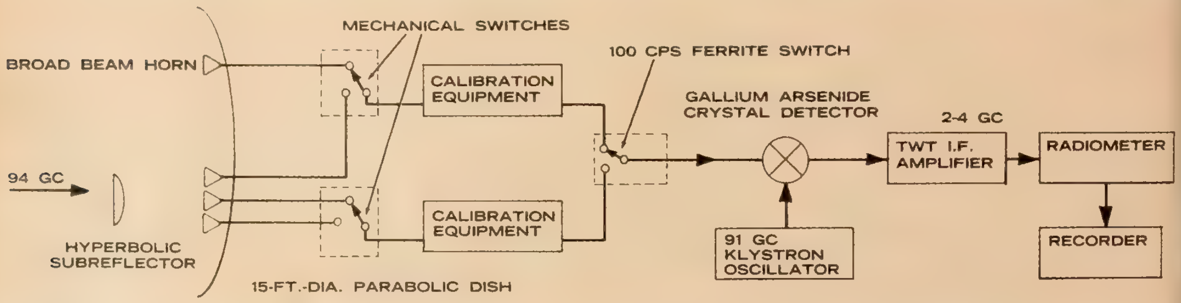
Improvements in techniques and components are expected to come from the millimeter research program with this antenna. In turn these improvements are expected to lead to Doppler navigation systems of very small size, communications systems secure from eavesdropping, and tracking radars of small size and high accuracy.

Because of the small size of millimeter components, space-borne applications of millimeter techniques look particularly promising.

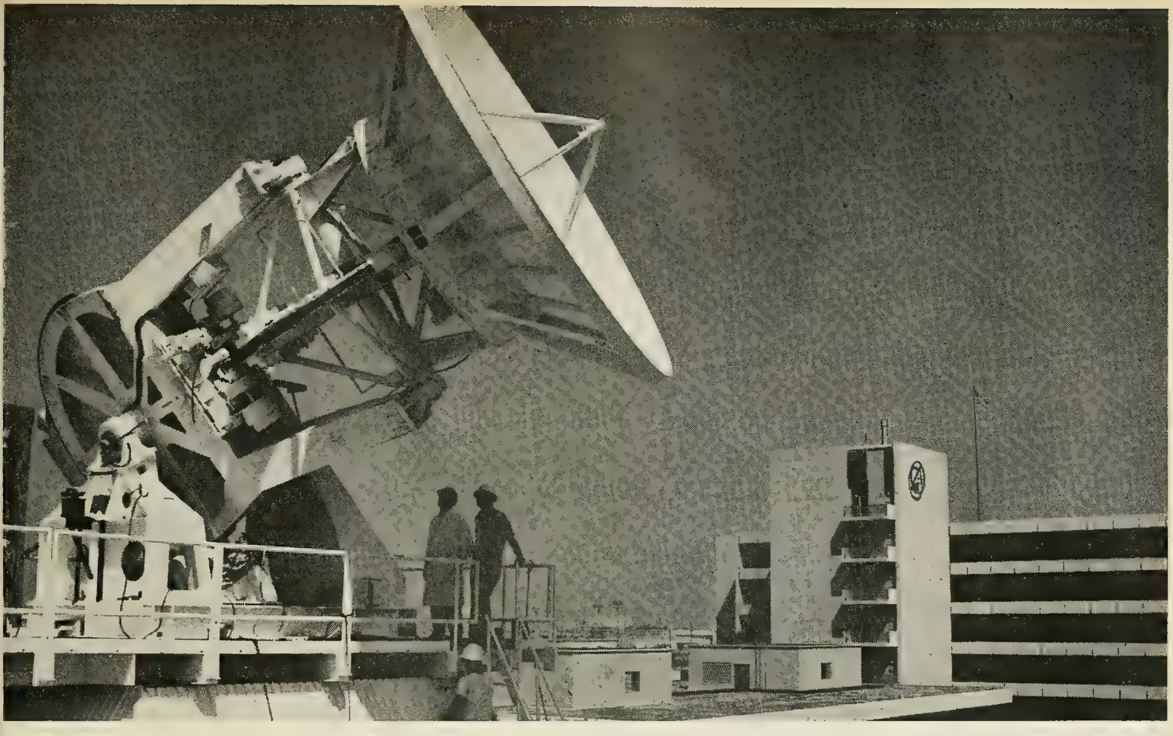
Chief problem at present is developing sufficient transmitting power at these wavelengths.

There are a number of "windows" in the absorption spectrum of the atmosphere at millimeter wavelengths. Low absorption occurs at 3.2, 2.2, and 1.2 mm. The high absorption regions in between are likely to be used for "secure" communications systems.

- **The assembly**—A 4.57-meter-dia. parabolic reflector and a hyperbolic sub-



ANTENNA FEED arrangements provide two narrow off-center beams, a narrow axial beam and a broad beam.



15-FT. DISH antenna atop building at El Segundo is main component of space radio systems facility.

reflector supported by a tetrapod structure make up the Cassegrainian assembly. Final parabolic contour was achieved by the precision milling of welded pre-formed aluminum gores.

Deviations from a true parabola are 0.0018 in. RMS, when the antenna points to the zenith. Combined effect of normal operating angles (less than 60 degrees from zenith), solar illumination, and 20-mph winds is to raise the deviation to 0.0031 in. RMS and 0.010 in. peak. At 1-mm wavelengths the reflector RMS error amounts to 0.08 λ.

Two 6-in.-dia. holes are bored through the main reflector, for installation of a boresight telescope and a television camera.

An equatorial mount, with a cantilevered antenna-to-mount support member to reduce horizon masking, carries the dish. A polar-axis alignment accuracy of ± 5 arc seconds and an angular deviation between the polar axis in the North-South line of not more than 2 arc seconds are sought.

Experiments planned for the antenna call for use of three narrow beams. Two feed horns off-axis provide beams that diverge at 12.5 arc minutes, symmetrically about the mechanical axis of the reflector.

In operation, one beam will be directed at the object under investigation, while the other will serve as a reference. As both beams tend to pass through the same atmospheric weather cells, cancellation of atmospheric temperature perturbations in the received signal should be possible.

An on-axis feed is also installed and this can be used in combination with a broad-beam horn mounted near the edge of the reflector.

A complete polarization capability is planned for the antenna, probably by use of a turnstile-junction feed configuration.

- **Location**—The antenna stands on a 17-ft tower located on the roof of a two-story building at Aerospace's El Segundo facility. Seismometers measuring building tilt showed movements of about 20 arc seconds during the day, due to thermal heating. These are compensated for in the digital control system.

The moving-coil and torsion seismometers used were capable of detecting angular deviations of the order of 0.01 arc second. Building movements attributable to such factors as trains, road traffic, air-conditioning machinery and wind did not exceed 0.1 arc second.

A hydraulic servo drive positions the antenna. Ephemeris data stored on magnetic tape are compared in the digital data processor with shaft-angle encoder outputs, and analog information is generated to actuate hydraulic drive motors.

The central data processor, a type 920 digital computer made by Scientific Data Systems Inc., allows for building tilt and atmospheric refraction. Inputs to the computer include atmospheric pressure, temperature, tilt north-south, tilt east-west, humidity, wind velocity, wind direction, rainfall rate, and a radiometer or receiver signal.

The 920 also provides coded pulse trains to operate calibration switches for radiometers and receivers, provides real-time data processing of receiver outputs, and computes and displays data such as right ascension, hour angle, declination, and sidereal time.

Input, output, and compute functions are carried on simultaneously. The data processor has a word length of 24 bits, a multiply time of 32 microsec., and a memory capacity of 4,000 words. Four magnetic tape units with 200 bits per in. packing density are installed.

Both hour-angle and declination axis are encoded into 20-bit binary numbers with a peak error of less than 5 arc seconds. Encoded angles can be sampled at a 10-kc rate.

Incoming millimeter signals at 94 gc are mixed in a gallium arsenide crystal detector with the 91-gc output of an RCA klystron oscillator. Main requirement for the mixer crystal, made by Electronic Communications Inc., Timonium, Md., was very wide bandwidth. The IF bandwidth of the millimeter receiver extends from 2 to 4 gc, and amplification is achieved with a Watkins-Johnson travelling-wave tube. ■

TUBE DIVISION, *Palo Alto, California* | **BOMAC DIVISION**, *Beverly, Massachusetts* | **VARIAN ASSOCIATES OF CANADA, LTD.**, *Georgetown, Ontario* | **SEMICON ASSOCIATES, INC.**, *Lexington, Kentucky* | **S-F-D LABORATORIES, INC.**, *Union, New Jersey*
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The shortest wavelengths in broadband recording are less than five times those of visible light. To magnetically record and reproduce such wavelengths requires a tape surface smoothness approaching that of an optical surface.

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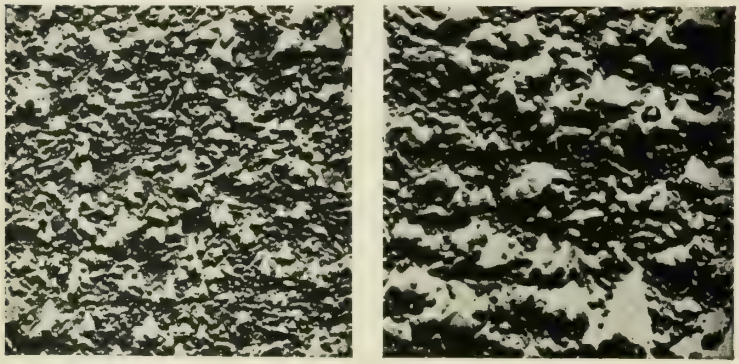
Electron microphotographs of surfaces of Memorex tape and competitive product at the same magnification (6000x).



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Users of Memorex Type 62 Broadband Tapes receive important performance advantages, including:

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Digital or pulse recording applications—The smooth, thin coatings of Type 62 Broadband Tapes will provide the higher resolution and greater pulse packing densities required by advanced recording systems.

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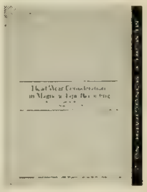
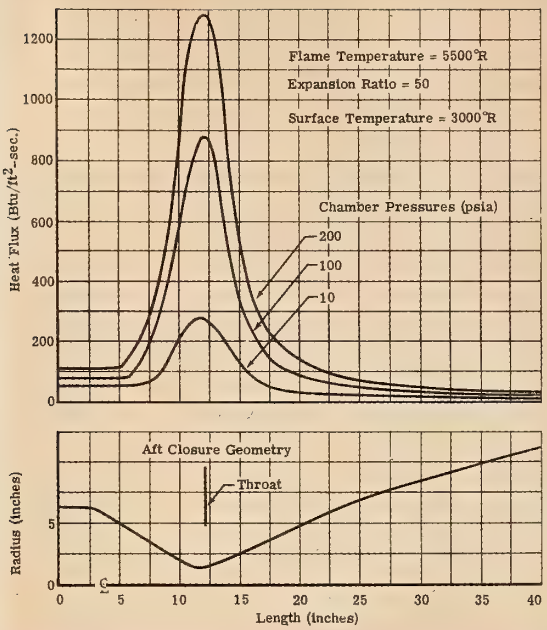
MEMOREX Monograph #2, titled *"Head Wear Considerations in Magnetic Tape Recording,"* available free on request. Write MEMOREX at address above.



MEMOREX CORPORATION
PRECISION MAGNETIC TAPE

Emerson Offers A Solution to Nozzle Problem

'Thermo-Lag' concept would cool nozzle while maintaining dimensional stability



A NEW APPROACH to providing thermal protection in crucial nozzle areas without sacrificing exact dimensional stability is being proposed by the Electronics and Space Division of Emerson Electric Mfg. Co.

The concept involves the controlled mass injection of Emerson's "Thermo-Lag" subliming material (M/R, Jan. 28, p. 38) through the walls of a porous nozzle made from highly thermal-conductive materials.

The Emerson proposal is based on use of controlled ejection of gases from a thermostatic sublimer through a porous liner—such as foamed metal carbides—with continuous capillary structure. The liner would be installed in the throat section of the nozzle.

The remaining parts and chamber structure could be coated with T-300 Thermo-Lag, which sublimes at about 300°F.

• **Future rockets**—The Thermo-Lag injectant cooling concept is specifically aimed at advanced engines of the liquid hydrogen-LOX and oxygen difluoride-hydrogen types. These units will have to operate for long durations with low mass flow, severe thermal shocks, and prolonged exposure to the space environment. Combustion temperatures exceed 8,000°F in some cases.

In addition, multiple restarts will be required with high impulse fuels of extreme chemical activity. Mechanical and acoustical shock will be present as well as gravity loading during launch.

One design approach worked out at Emerson has the nozzle liner located immediately behind, yet intimately adjacent to, the porous liner. The nozzle liner itself is composed of a conductive grid impregnated with the subliming matrix.

The conductive grid is designed to provide a sufficient thermal path from the porous liner to the subliming material so that the liner will be provided with adequate heat blockage to maintain maximum wall temperature commensurate with the requirement of continuous porosity.

The subliming impregnate itself will be maintained in a conductive matrix to insure the adequate thermal path required for proper sublimation.

• **Subtle advantages**—Besides the cooling effect achieved through sublimation, additional cooling is gained by the endothermic dissociation of the subliming gases within the heat exchanging porous liner, as well as within the boundary layer of subliming gases that shield the porous liner from direct contact with the environmental stream.

Emerson spokesmen list other advantages besides the possible dimensional stability. These include considerable weight savings, high mechanical and shock resistance together with improved mechanical strength and controlled liner surface temperature.

The Thermo-Lag trademark actually represents a variety of compositions—all of which are designed to sublime at a specific temperature. Compounds under development cover the temperature range from 160°F to 2,200°F, but higher limits are practicable.

The compositions are formed by dissolving specified inorganic subliming compounds in an appropriate solvent such as propanol, isopropanol or ethyl alcohol. The viscosity, boiling point and amount of solvent is determined by the end use of the particular formulation. The solvents must not react with the sublimating materials and must evaporate below the formulation operating temperature.

Resin content and type is similarly determined if the formulation calls for binders. Phenol-formaldehyde is a typical thermosetting resin used in high-temperature formulations.

While Thermo-Lag compositions provide thermostatic temperature control through the sublimation of inorganics, the total effect is much greater than would be expected from just utilizing the latent heat of sublimation.

This results from a combination of the latent heat of sublimation with thermal diffusivity, mass transfer and an increase in boundary layer low-molecular-weight gases.

The sublimating compounds are being used in a host of space programs. The only major comment from users has centered around the material's cost, but the economics of application more than offset this. ■

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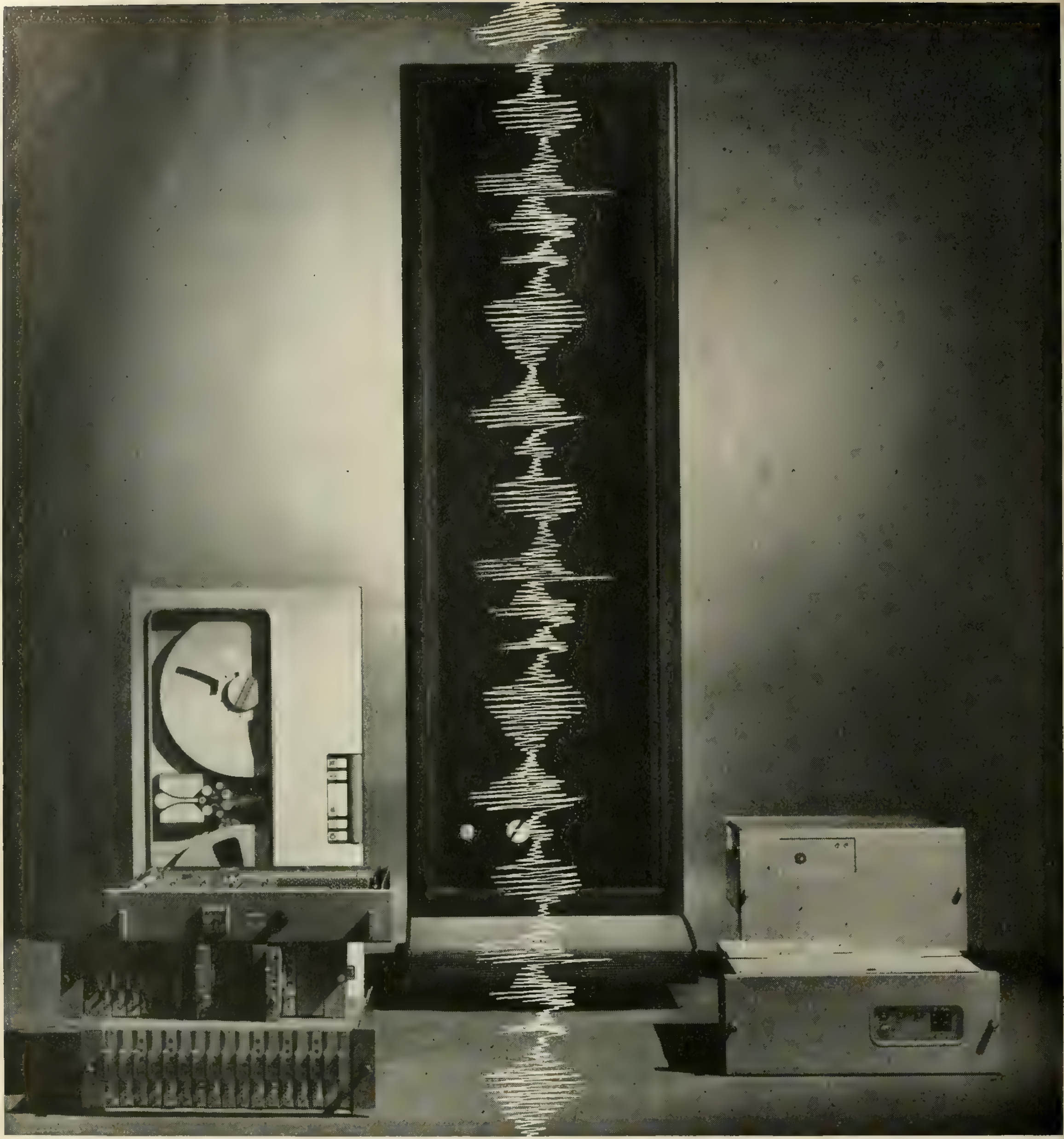

What new data recorder can be simple – or sophisticated? AMPEX FR-1200

Here's the newest recorder from Ampex—the FR-1200. It's a medium-priced, basic data recorder that's modular in design and built for long-term reliable operation. With the FR-1200, you're offered various types of electronics and accessories, and with these you can tailor a recorder as simple or as sophisticated as you want—one that meets your needs and budget now, and can be expanded as you grow. You can start at the simplest level—a one-speed, record-only recorder—and build all the way to a 14-track, record/reproduce system with six-speed (1⅞ ips to 60 ips) electrically switchable electronics and transport. Ampex ES-100 solid state electronics offer Direct recording to 300 KC, FM recording to 20 KC, or IRIG compatible PDM. The FR-1200 also features a new tape transport. Rugged and reliable, it offers low flutter, prevents tape stress during fast starts, provides constant tape tension on both reels and has new tape braking and guidance systems. For details write: Ampex Corporation, Redwood City, California. Sales and service engineers throughout the world.

AMPEX

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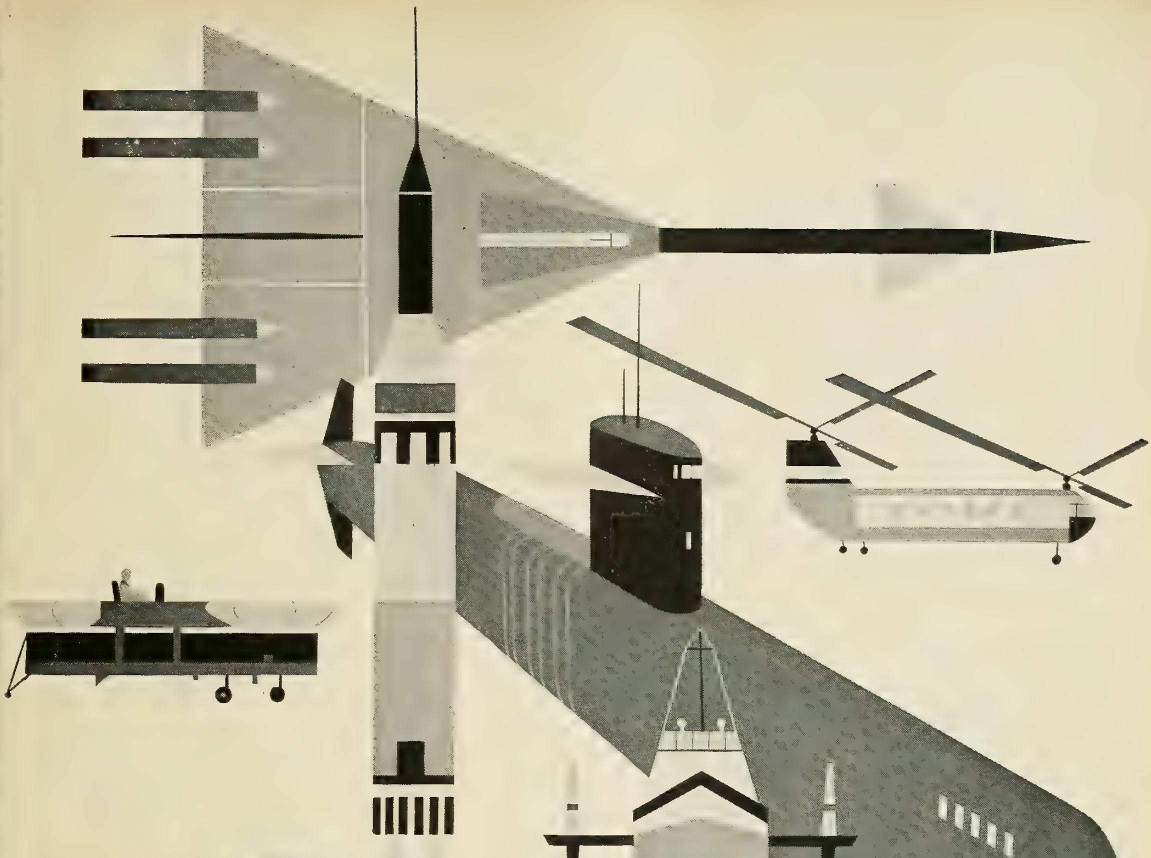

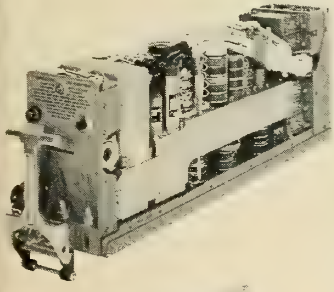

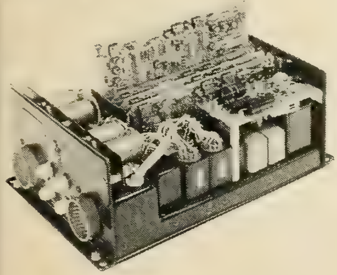

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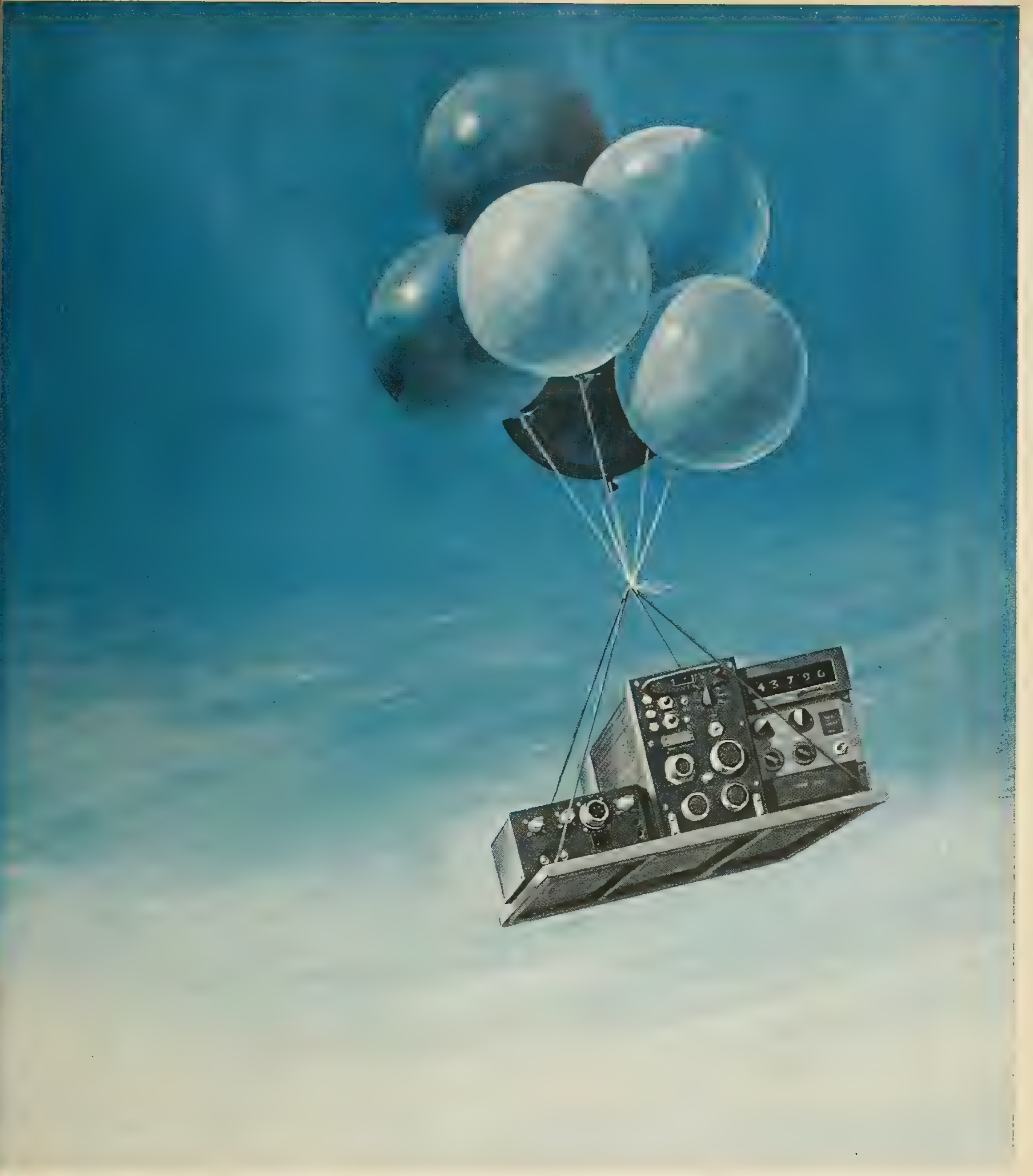

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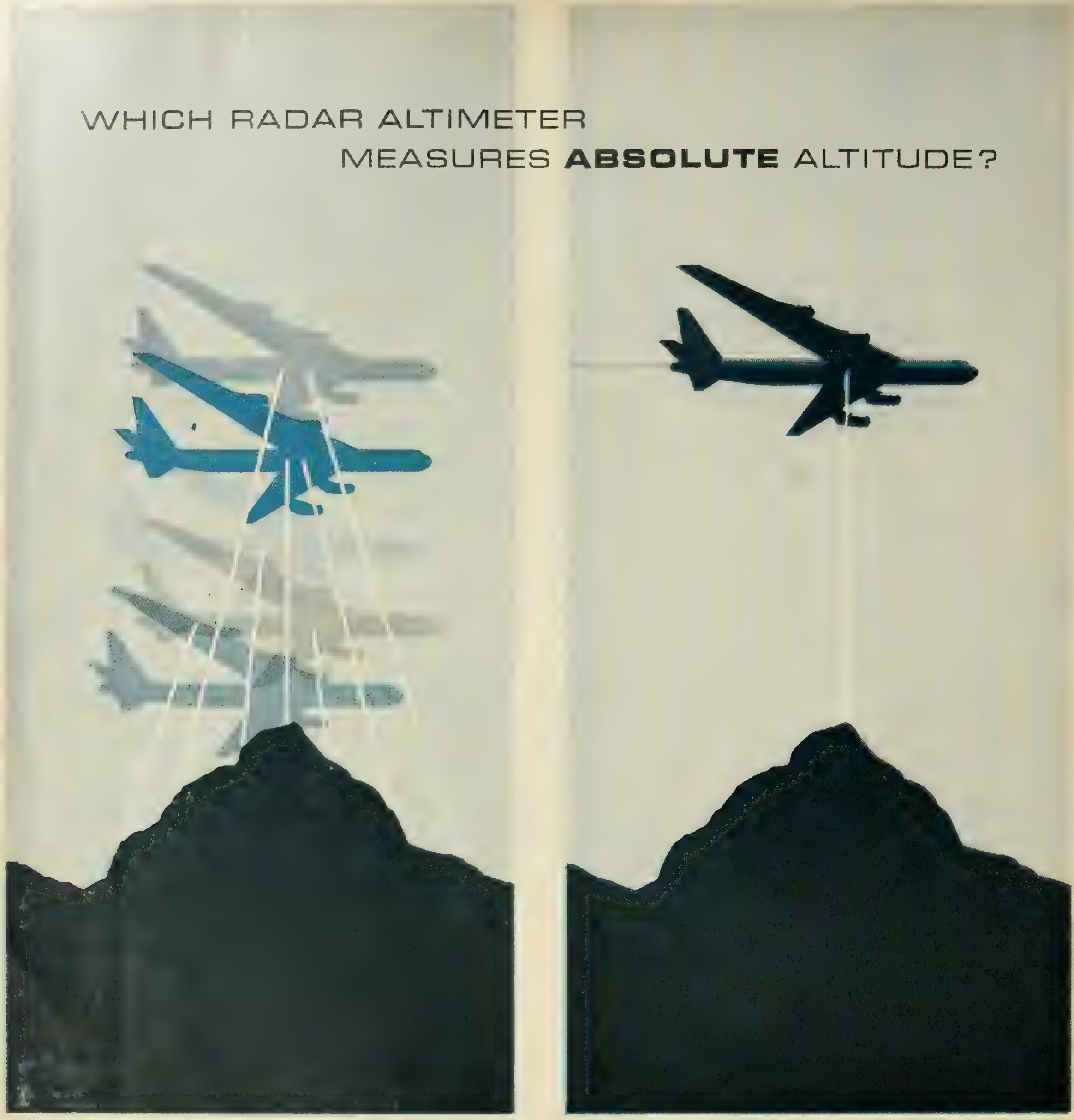

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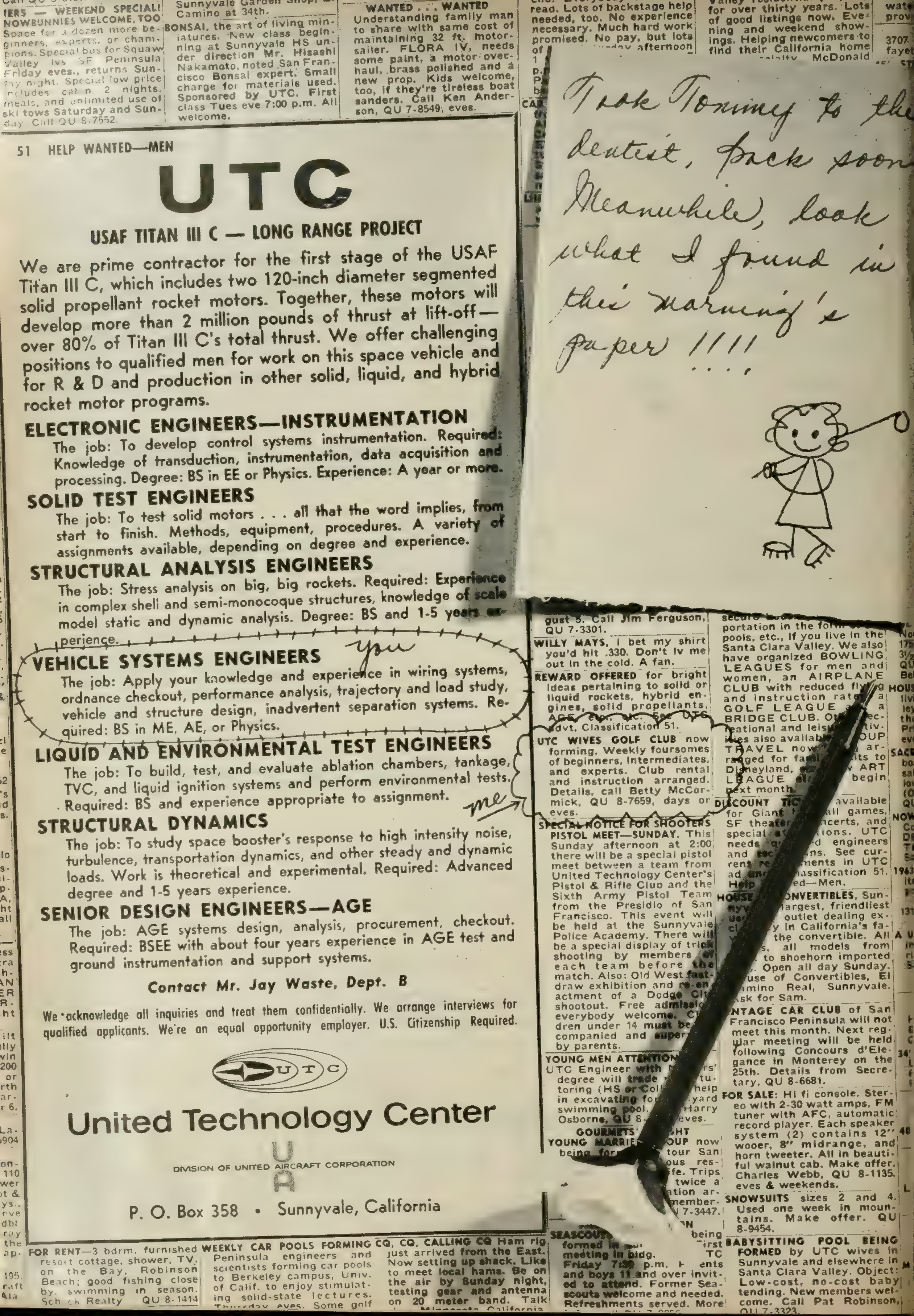

IERS — WEEKEND SPECIAL! NOWBUNNIES WELCOME, TOO. Space for a dozen more beginners, experts, or champions. Special bus for Squaw Valley lvs SF Peninsula Friday eves., returns Sunday night. Special low price includes cabin 2 nights, meals, and unlimited use of ski tows Saturday and Sunday. Call QU 8-7552.

Sunnyvale Garden Shop, El Camino at 34th.

BONSAI, the art of living miniatures. New class beginning at Sunnyvale HS under direction Mr. Hisashi Nakamoto, noted San Francisco Bonsai expert. Small charge for materials used. Sponsored by UTC. First class Tues eve 7:00 p.m. All welcome.

WANTED . . . WANTED
Understanding family man to share with same cost of maintaining 32 ft. motor-sailer. FLORA IV, needs some paint, a motor overhaul, brass polished and a new prop. Kids welcome, too, if they're tireless boat sanders. Call Ken Anderson, QU 7-8549, eves.

read. Lots of backstage help needed, too. No experience necessary. Much hard work promised. No pay, but lots of

for over thirty years. Lots of good listings now. Evening and weekend showings. Helping newcomers to find their California home McDonald

51 HELP WANTED—MEN

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USAF TITAN III C — LONG RANGE PROJECT

We are prime contractor for the first stage of the USAF Titan III C, which includes two 120-inch diameter segmented solid propellant rocket motors. Together, these motors will develop more than 2 million pounds of thrust at lift-off—over 80% of Titan III C's total thrust. We offer challenging positions to qualified men for work on this space vehicle and for R & D and production in other solid, liquid, and hybrid rocket motor programs.

ELECTRONIC ENGINEERS—INSTRUMENTATION

The job: To develop control systems instrumentation. Required: Knowledge of transduction, instrumentation, data acquisition and processing. Degree: BS in EE or Physics. Experience: A year or more.

SOLID TEST ENGINEERS

The job: To test solid motors . . . all that the word implies, from start to finish. Methods, equipment, procedures. A variety of assignments available, depending on degree and experience.

STRUCTURAL ANALYSIS ENGINEERS

The job: Stress analysis on big, big rockets. Required: Experience in complex shell and semi-monocoque structures, knowledge of scale model static and dynamic analysis. Degree: BS and 1-5 years experience.

VEHICLE SYSTEMS ENGINEERS

you

The job: Apply your knowledge and experience in wiring systems, ordnance checkout, performance analysis, trajectory and load study, vehicle and structure design, inadvertent separation systems. Required: BS in ME, AE, or Physics.

LIQUID AND ENVIRONMENTAL TEST ENGINEERS

The job: To build, test, and evaluate ablation chambers, tankage, TVC, and liquid ignition systems and perform environmental tests. Required: BS and experience appropriate to assignment.

me

STRUCTURAL DYNAMICS

The job: To study space booster's response to high intensity noise, turbulence, transportation dynamics, and other steady and dynamic loads. Work is theoretical and experimental. Required: Advanced degree and 1-5 years experience.

SENIOR DESIGN ENGINEERS—AGE

The job: AGE systems design, analysis, procurement, checkout. Required: BSEE with about four years experience in AGE test and ground instrumentation and support systems.

Contact Mr. Jay Waste, Dept. B

We acknowledge all inquiries and treat them confidentially. We arrange interviews for qualified applicants. We're an equal opportunity employer. U.S. Citizenship Required.

UTC

United Technology Center

DIVISION OF UNITED AIRCRAFT CORPORATION

P. O. Box 358 • Sunnyvale, California

Took Tommy to the dentist, back soon

Meanwhile, look what I found in this morning's paper !!!!

gust 5. Call Jim Ferguson, QU 7-3301.

WILLY MAYS. I bet my shirt you'd hit .330. Don't lv me out in the cold. A fan.

REWARD OFFERED for bright ideas pertaining to solid or liquid rockets, hybrid engines, solid propellants, AGE, etc., etc. See UTC advt, Classification 51.

UTC WIVES GOLF CLUB now forming. Weekly foursomes of beginners, intermediates, and experts. Club rental and instruction arranged. Details, call Betty McCormick, QU 8-7659, days or eves.

SPECIAL NOTICE FOR SHOOTERS PISTOL MEET—SUNDAY. This Sunday afternoon at 2:00 there will be a special pistol meet between a team from United Technology Center's Pistol & Rifle Club and the Sixth Army Pistol Team from the Presidio of San Francisco. This event will be held at the Sunnyvale Police Academy. There will be a special display of trick shooting by members of each team before the match. Also: Old West fast-draw exhibition and re-enactment of a Dodge City shootout. Free admission, everybody welcome. Children under 14 must be accompanied and supervised by parents.

YOUNG MEN ATTENTION UTC Engineer with Masters' degree will trade tutoring (HS or Coll help in excavating for yard swimming pool. Harry Osborne, QU 8- eves.

GOURMETS NIGHT
YOUNG MARRIED GROUP now being for tour San ous res fe. Trips twice a ation arranged member. 7-3447.

SEASCOUTS being formed in first meeting in bldg. TC Friday 7:30 p.m. Parents and boys 11 and over invited to attend. Former Seascouts welcome and needed. Refreshments served. More

portation in the form of car pools, etc., if you live in the Santa Clara Valley. We also have organized BOWLING LEAGUES for men and women, an AIRPLANE CLUB with reduced flying and instruction rates, a GOLF LEAGUE and a BRIDGE CLUB. Other recreational and leisure activities also available. GROUP TRAVEL now arranged for family visits to Disneyland, etc. ART LEAGUE begin next month.

DISCOUNT TICKETS available for Giant ball games, SF theater, concerts, and special attractions. UTC needs qualified engineers and technicians. See current requirements in UTC ad under Classification 51. Help Wanted—Men.

HOUSE OF CONVERTIBLES, Sunnyvale's largest, friendliest used car outlet dealing exclusively in California's favorite, the convertible. All makes, all models from to shoehorn imported. Open all day Sunday. House of Convertibles, El Camino Real, Sunnyvale. Ask for Sam.

VINTAGE CAR CLUB of San Francisco Peninsula will not meet this month. Next regular meeting will be held following Concours d'Elegance in Monterey on the 25th. Details from Secretary, QU 8-6681.

FOR SALE: Hi fi console. Stereo with 2-30 watt amps, FM tuner with AFC, automatic record player. Each speaker system (2) contains 12" wooer, 8" midrange, and horn tweeter. All in beautiful walnut cab. Make offer. Charles Webb, QU 8-1135, eves & weekends.

SNOWSUITS sizes 2 and 4. Used one week in mountains. Make offer. QU 8-9454.

BABYSITTING POOL BEING FORMED by UTC wives in Sunnyvale and elsewhere in Santa Clara Valley. Object: Low-cost, no-cost baby tending. New members welcome. Call Pat Robinson, QU 7-3323.

FOR RENT—3 bdrm. furnished resort cottage, shower, TV, on the Bay, Robinson Beach; good fishing close by, swimming in season. Schock Realty QU 8-1414

WEEKLY CAR POOLS FORMING Peninsula engineers and scientists forming car pools to Berkeley campus, Univ. of Calif. to enjoy stimulating solid-state lectures. Thursday eves. Some golf

CQ, CQ, CALLING CQ Ham rig just arrived from the East. Now setting up shack. Like to meet local hams. Be on the air by Sunday night, testing gear and antenna on 20 meter band. Talk

Electronics Sales Set Record

Electronics industry sales for 1963 are predicted to rise 11% above last year's record $13.8 billion. Charles F. Horne, president of the Electronics Industries Assn., told the EIA Winter Conference he expected more than $15.3 billion in industry sales this year and continued healthy growth in 1964. However, he predicted a drop in the growth rate for 1964 compared to this year. Government sales accounted for about 60% of the 1963 sales, said Horne. The industry official said he felt it too early to predict the effect of recent trends toward more economy in government spending.

Mergers and Acquisitions

Aerospace Components Div. of Atlas Chemical Industries, Inc., Wilmington, Del., has purchased the equipment of Metaglass Corp., Vineland, N.J. The equipment, used for the production of glass-to-metal seals, is being installed in the new ACD plant at Valley Forge, Pa. . . . *MB Electronics, New Haven, Conn., has purchased an exclusive license to manufacture and sell specialized material test machines and accessories from the Marquardt Corp., Van Nuys, Calif. The agreement includes a provision for MB Electronics to eventually acquire sole property rights to the test machine business. The hydraulically powered servo-controlled universal test machine was developed by Marquardt engineers for testing materials for various aerospace applications over a wide range of precisely controlled stresses, strains and temperatures* . . . Xerox Corp., Pasadena, Calif., has completed the major exchange of shares that makes Electro-Optical Systems, Inc., a Xerox subsidiary. Through an agreement announced by the two firms in August, 35,208 shares of Xerox stock were exchanged with major EOS shareholders for 563,325 of that corporation's shares. EOS is engaged in research, development and engineering for spacecraft propulsion systems, upper atmospheric environmental probes, spacecraft electrical power systems, laser research, microelectronics and image intensification devices. . . . *Baldwin-Lima-Hamilton Corp.'s Electronics Div., Philadelphia, has acquired a strip chart recorder line from the Massa Div. of Cohu Electronics, Hingham, Mass. BLH obtained full and exclusive rights under the Massa patents for the manufacture and world-wide sale of the Massa high-speed strip chart recorders and oscillograph recorder systems.*

New Firms and Divisions

Bulova Watch Co., Inc., has formed a Systems and Instruments Div. in New York City in an effort to combine research experience in electro-mechanics and electro-optics with precision manufacturing. The new division incorporates Bulova's Research and Development Laboratories, Timer Engineering section and Industrial and Military Products Div. . . . *Arinc Research Corp., Washington, D.C., has opened a Western Div. in Santa Ana, Calif., as a part of company expansion in the western part of the country. . . .* Joslyn Manufacturing and Supply Co., Chicago manufacturer of pole line hardware and other electrical equipment, has opened a new operating division, Joslyn Electronic Systems, in Chicago. The division will manufacture electronic surge protection apparatus and systems and a variety of electronic components.

International

Six new foreign sales and service representatives have been appointed by Hydro-Line Manufacturing Co., Rockford, Ill., manufacturer of precision air and hydraulic cylinders: Amal, Ltd., Birmingham, England; Main Hydraulic Pty., Ltd., Victoria, Australia; Vagnone & Boeri, Torino, Italy; Racine Und Vickers Armstrongs GmbH, Offenbach/Main, Germany; LeMoine de Mexico, Mexico City, Mexico; and Impulsora Industrial del Norte, Monterrey, Mexico. Each firm will engineer, sell and service all Hydro-Line products, including hydraulic cylinders, air cylinders, adjustable-stroke cylinders, boosters, dispensing cylinders, single-acting cylinders, self-aligning rod end couplers, and cylinders with limit-switch actuators. . . . *Varo-Atlas, GmbH, Bremen, West Germany, jointly owned by Varo, Inc., of Garland, Tex., and Atlas-Werke AG of Bremen, Germany, has selected Service Industrielles et Electroniques as exclusive sales agent for Varo, Inc., products in France. V-A produces static power and magnetic devices.*

In the Courts

A patent infringement suit brought last January by Westinghouse Electric Corp. against International Rectifier Corp. concerning two semiconductor patents has been settled. Under terms of the settlement, IR has taken a license under the two Westinghouse power rectifier patents and has agreed to pay back royalties for past infringement. . . . *Sprague Electric Co. and Nuclear Corp. of America have announced that an action for alleged patent infringement and misappropriation of trade secrets brought by Sprague against Nuclear in the U.S. District Court for Arizona has been amicably settled. SE has granted to NCA an irrevocable non-exclusive license to make, use and sell solid electrolyte tantalum capacitors under Sprague's U.S. Patents Nos. 2,936,514 and 3,066,247.*

Industry Facilities

Kaman Aircraft Corp. is completing facilities at its Moosup, Conn., plant to carry out chem-milling of missile/space parts. . . . *Epsco, Inc., Cambridge, Mass., this month will complete relocation to a new 60,000 sq.-ft. plant in Westwood, Mass. The new facility is designed to accommodate electronic research and manufacturing activities.*

AWARDS

AIR FORCE

$9,500,000—**Thompson Ramo Wooldridge, Inc.**, Redondo Beach, Calif., for engineering services related to ballistic missile programs (supplemental contract).

$5,700,000—**Mitre Corp.**, Bedford, Mass., for further work in research and development toward a command-and-control system.

$5,300,000—**Avco Corp., Lycoming Div.**, Stratford, Conn., for further work on missile re-entry vehicles.

$3,500,000—**Western Electric Co.**, New York City, for manufacture of an improved UHF air-to-ground communications system.

$3,400,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for work on a satellite control network.

$3,200,000—**General Precision, Inc.**, Glendale, Calif., for further work and production of related data-processing equipment for use in the 473L system.

$2,800,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for lead-time items for *Agena* boosters.

$2,200,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for launch services at the Pacific Missile Range.

$2,200,000—**North American Aviation, Inc., Space and Information Systems Div.**, Downey, Calif., for engineering work on the *Hound Dog* missile.

$2,088,000—**Curtiss-Wright Corp.**, Wood-Ridge, N.J., for development and fabrication of a lightweight gas generator whose major components comprise the basic design of a new concept turbojet.

$1,600,000—**Emerson Electric Manufacturing Co.**, St. Louis, for continued work on automatic test equipment for UHF communication sets

$1,500,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for long leadtime equipment and related items for the *Agena* upper-stage booster.

$1,300,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for continued work on *Atlas* and *Titan* missile subsystems.

$1,000,000—**Avco Corp.**, Stratford, Conn., for work on a missile re-entry system.

$1,000,000—**Philco Corp., Aeronutronic Div.**, Newport Beach, Calif., for studies to develop systems, methods of overcoming enemy radar and ABM target defenses (work will be classified).

$500,000—**General Electric Co., Re-entry Systems Dept.**, Philadelphia, for work on a re-entry systems definition study (supplemental contract).

$350,000—**Standard Pressed Steel Research and Development Laboratory**, Jenkintown, Pa., for a combined study of ultra-high temperature fasteners and coatings.

$332,000—**Republic Aircraft Corp.**, Farmingdale, N.Y., for a study of multiplexing techniques for very wideband signals.

$161,270—**Astrosystems International, Inc.**, Caldwell, N.J., for a study and solution of rocket engine installation problems related to maneuverable satellite vehicles.

$149,973—**Aerojet-General Corp., Liquid Rocket Plant,** Sacramento, Calif., for a feasibility study of a tri-propellant feed system.

ARMY

$10,600,000—**General Dynamics Corp.**, Pomona, Calif., division, for continued research and development on the *Mauler* missile weapon system.

$5,000,000—**Philco Corp.**, Philadelphia, for electronics equipment.

$5,000,000—**General Telephone and Electronics Corp., Sylvania Electric Products Div.**, Needham, Mass., for advanced electronic equipment parts and related items.

$1,626,948—**Amron Corp.**, Waukesha, Wis., for classified components for projectiles.

$1,456,819—**C. H. Leavell & Co.** and **Peter Kiewit Sons' Co.**, El Paso, Tex., for construction of a central control building and data-handling center at NASA's Mississippi Test Operations.

$1,100,000—**Honeywell Regulator Co.**, Hopkins, Minn., for work on a classified project.

$90,000—**Radio Corp. of America**, Moorestown, N.J., for a feasibility study of an air defense system.

$38,955—**Textron Electronics, Inc., MB Electronics Div.**, New Haven, Conn., for electronic equipment for a vibration shaker system.

NAVY

$19,500,000—**General Electric Co.**, Pittsfield, Mass., for production of fire-control systems for *Polaris* missiles.

$6,200,000—**General Dynamics Corp.**, Pomona, Calif., division, for a follow-on contract to produce guidance and control systems for *Tartar* and *Terrier* missile systems.

$3,800,000—**Sperry Rand Corp.**, Long Island City, N.Y., for modification kits for *Terrier* and *Tartar* missile systems.

$1,330,158—**Sperry Rand Corp.**, Great Neck, N.Y., for modification kits for missile radar sets.

$153,545—**B. F. Goodrich Aerospace Defense Products**, Akron, Ohio, for research and development of an improved model of the Mark IV full-pressure high-altitude flight suit

NASA

$6,143,000—**Boeing Co.**, Seattle, for manufacture of first stages for the 7.5-million-pound-thrust *Saturn V* rocket.

$2,500,000—**Ling-Temco-Vought, Inc.**, Dallas, for administrative and management services at the Merritt Island Launch Area.

$2,216,000—**Chrysler Corp.**, New Orleans, for assembly of the 1.5-million-pound-thrust first stage for the *Saturn I* and *IB* space vehicles.

$830,903—**Martin Marietta Corp.**, Denver, for advanced pressurization systems for cryogenic propellants.

$125,000—**Leeds & Northrop Co.**, Philadelphia, for development of a low-temperature digital automatic calibration system for the Marshall Space Flight Center. System will be used in work on rocket fuel temperature studies.

$60,002—**Lear Siegler, Inc.**, Anaheim, Calif., for a missile-borne television system.

INDUSTRY

$23,500,000—**Radio Corp. of America**, New York City, from **Grumman Aircraft Engineering Corp.**, for provision of the radar subsystem for the Lunar Excursion Module (LEM).

$4,500,000—**Minneapolis-Honeywell Regulator Co.**, Minneapolis, from **Atlantic Research Corp.**, for production of 78 attitude-control systems for *Athena* rockets.

$4,000,000—**General Dynamics Corp.**, San Diego, Calif., from **Ford Motor Co.'s Philco Corp. subsidiary**, for computer display equipment for NASA's Integrated Mission Control Center at Houston.

$775,000—**E. W. Bliss Co.**, Canton, Ohio, from **Martin-Denver**, for three sets of transporter frames and umbilical masts for the *Titan III* booster.

$500,000—**Purolator Products, Inc., On Mark Couplings Div.**, Rahway, N.J., from the **Boeing Co.**, for umbilical panel couplings for the S-IC first stage booster for *Saturn V*.

$275,000—**Ling-Temco-Vought's Ling Electronics Div.**, Anaheim, Calif., from the **Boeing Co.**, for a vibration environmental test system for the *Saturn* booster.

$159,067—**Bendix Corp.'s Pioneer-Central Div.**, Davenport, Iowa, from **Lockheed Missiles & Space Co.**, for provision of acceleration switches for the *Polaris* missile.

$71,000—**Ryan Aeronautical Co.**, San Diego, from the **Boeing Co.**, for provision of separation rings for the *Minuteman* missile program.

North American Aviation, Inc., Columbus, Ohio, division, from the **University of Miami**, Fla., for the design, development and testing of a unique underwrater acoustic projector (undisclosed amount).

REQUEST FOR BIDS

GENERAL PROCUREMENTS

Directorate of Procurement, R&D
Systems Engineering Group (RTD)
Wright-Patterson AFB, Ohio

Negotiations will be conducted with Aerojet-General Corp., Azusa, Calif., for additional work and modification of the toxic hazard research units being developed under Contract AF 33(657)-11305. For information only; no RFP available PR 61157-KMB.

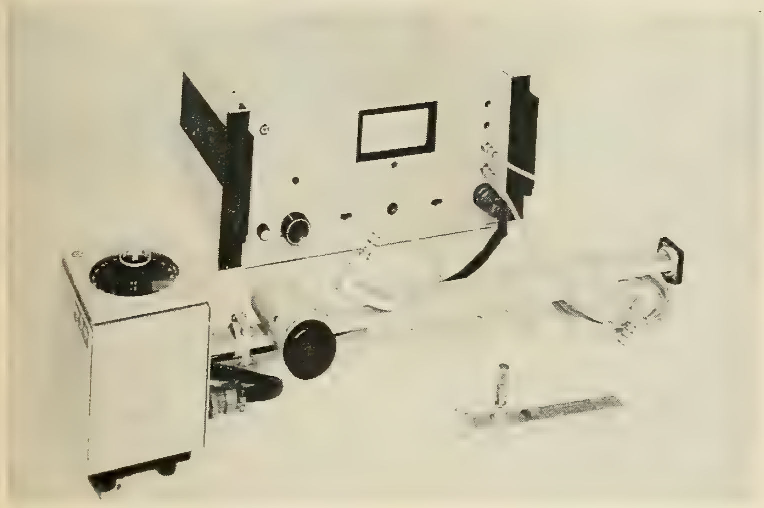
U.S. Army Missile Command
Redstone Arsenal, Ala.
(AMSMI-IXG)

Contract for experimental, developmental and research work in support of solid hybrid propellants for rockets, missiles and gas generators to be negotiated with the Rohm and Haas Co., Redstone Arsenal Research Div., Huntsville, Ala. Modification No. 11 to contract DA-01-021 ORD-11878(Z). It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the firm listed.

Contract for research and development to provide a design concept of a technique of impulse control for guided missiles to be negotiated with the Thiokol Chemical Corp., Alpha Div., Huntsville Plant, Huntsville, Ala. Contract No. DA-01-021 AMC-10039(Z). It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the firm listed.

Contract to perform a continuation of research and experimental effort in support of guided missiles, motor development and solid propellants involving problems of propulsion technology to be negotiated with the Rohm and Haas Co., Redstone Arsenal Research Div., Huntsville, Ala. Modification to Contract No. DA-01-021 AMC-10037(Z). It is suggested that firms and others interested in subcontracting opportunities make direct contact with the above firm.

New Product of the Week: VSWR Measuring System



California Technical Industries Div. of Textron, Inc., is marketing the Model 305 VSWR measuring system.

The unit is supplied for X-band, 8,500 to 9,600 mc with 1,000 cps per square-wave modulation; other frequencies are available on request. Overall accuracy is less than 2%.

The unit features continuous VSWR versus frequency measurements, single-knob operation and zero-set not required.

Circle No. 225 on Subscriber Service Card

X-Y Pedestal

An X-Y pedestal featuring a one-milliradian tracking accuracy in both axes had been developed by Antenna Systems, Inc.

The unit will carry a reflector up to 30 ft. in dia. and will maintain accuracy in winds up to 45 mph. Pedestal compliance is 2.5 x 10^{-6} degrees per ft.-lb., and backlash in the power train is 20 arc sec.

Maximum unbalanced moment is 50,000 ft.-lb. in both axes; survival overturn moment torque is 100,000 ft.-lb. (stowed). For both axes, maximum angular velocity is 15 degrees/sec.; maximum angular acceleration is 5 degrees/sec.^{2}; sky coverage is from zenith down to 90 degrees in any plane.

Circle No. 226 on Subscriber Service Card

Line-Type Modulator

A solid-state line-type modulator, described as half the size of conventional units, has been introduced by Raytheon Co.'s Magnetics Operation.

The device has a input of 115v, 400 cps, and output of 5.4 kv. Peak current is 4.5 amp for a 1.5 μsec pulse width. Repetition rate is 800 pulses per second. The device can be modified to meet specific requirements.

Circle No. 227 on Subscriber Service Card

Two-Gang Potentiometers

Astro Electronics, Inc., is marketing a series of two-gang, single-turn potentiometers designed for operation in atmospheres containing nitrogen textroxide, hydrazine and U.N.S. dimathyhydrazine.

Designated the 088-1-200 series, the units meet MIL-E-5272C and MIL-P-26539A specifications. They are available with linearities up to 0.75%. Nonlinear functions may be converted to special uses.

The series operates in a temperature range of −65° to 160°F. Functional angle is 355 (±5) degrees. Starting torque is 4 in-oz.; running torque is 2 in.-oz. Leads and mounting base plates are supplied to customer requirements.

Circle No. 228 on Subscriber Service Card

A C Ratio Box

A programmable inductive ratio box that uses crystal-can relays operable from cards or punched tape has been developed by North Atlantic Industries, Inc.

The device can switch in any ratio in the 1.111110 to −1.111110 range with a seven-digit resolution. Designated the PRB-507T, the unit features an inverting isolation transformer, also programmable. Set-up time is 5 ms. Frequency range is 50 to 10,000 cycles, covering input voltage 0.75f to 350v maximum, where f is the operating frequency.

Circle No. 229 on Subscriber Service Card

Pressure Switch/Indicator

A differential pressure switch and indicator adjustable for actuation from 60 to 140 psid has been developed by Aircraft Porous Media, Inc., for use in high-pressure gas systems.

The device is placed across filters to detect excessive pressure drop resulting from contamination of the filter element. It is rated to 6,000 psi operating pressure; 12,000 psi proof pressure and 24,000 psi burst pressure. The pressure-sensing mechanism uses no external moving seals and allows the electrical switch to be isolated from the system fluid. Actuation is visible through windows.

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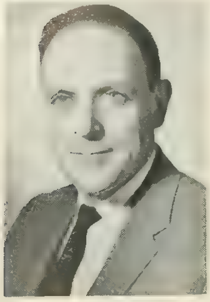
names in the news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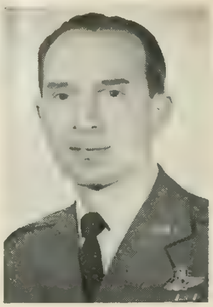
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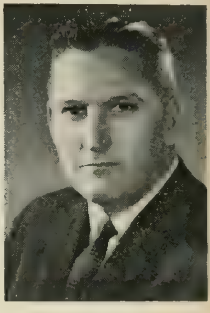
GROHE

E. Douglas, Kenna: Elected vice president of Avco Corp., Wilmington, Mass.

Elliot Ring: Appointed director of design and development at Martin Co's Orlando, Fla., Div.

Col. George D. Colchagoff: Named chief of the Propulsion Research Div., AF Office of Scientific Research, Washington, D.C.

Willis R. Peterson: Appointed chief of the checkout and monitoring systems group in the Systems Support Dept. of Northrop Corp.'s Nortronics Div., Anaheim, Calif.

Burt F. Raynes: Named president and general manager of Rohr Corp., Chula Vista, Calif.

D.P. Armstrong: Appointed director of the space experiments program office at aerospace Corp., El Segundo, Calif. **L. Frank Eliel** named head of the operations and logistics costs section.

Earl F. Kotts: Named assistant patent counsel for the Astronautics Div. of General Dynamics Corp., San Diego, Calif.

Murray Weingarten: Promoted to vice president for operations for Bendix Field Engineering Corp., Owings Mills, Md.

Lester R. Grohe: Appointed vice president of the Nortronics Div. of Northrop Corp., and manager of its Precision Products Dept., Norwood, Mass.

Allen L. Byron: Named administrative manager of Vitro Corp.'s Silver Spring, Md., Laboratory.

Benjamin Adler: Elected vice president of Litton Industries, New Rochelle, N.Y.

Raymond F. Wormwood: Joined Sylvania Electric Products, Inc., as manager of the contracts branch of the **Minuteman** ground electronic program, Waltham, Mass.

Robert E. Mason: Appointed marketing manager for Decisional Control Associates, Inc., Newport Beach, Calif.

George Eisler: Appointed director of advanced planning and design for Scientific Data Systems, Santa Monica, Calif.

William E. Bushor: Appointed director of information services for Bryant Computer Products, Detroit.

David W. Pertschuk: Appointed corporate director of reliability and quality assurance for the Fairchild Stratos Corp., Hagerstown, Md.

R. A. Sherbondy: Named corporate vice president of Aerospace Leasing Corp., El Segundo, Calif.

Ray E. Aarestad: Named director of the Test Dept., at the Martin Co.'s Denver Div.

Edward W. Virgin: Named a vice president of Bell Aerosystems Co., Buffalo, N.Y.

Marshall B. Cohen: Promoted to assistant head of the Computer Services Dept. of Cornell Aeronautical Laboratory, Buffalo, N.Y.

George G. Barker, manager of Raytheon Company's Technical News Section, died suddenly Dec. 9 after a brief illness.

Mr. Barker, who was 55 years old, served with Raytheon for 21 years. He was a graduate of Harvard College and attended Harvard Business School. He is survived by his wife, a daughter, and two grandchildren.

J. A. V. Hyatt: Named general manager of the Davidson Div., of Fairchild Camera and Instrument Corp., Commack, L.I., N.Y. **Edward P. Tracht** named general manager of Fairchild Graphic Equipment, Plainview, L.I., N.Y.

Dr. Launor F. Carter: Elected a senior vice president of System Development Corp., Santa Monica, Calif.

Nicholas Ovuka: Appointed by Aerojet-General Corp., as Washington, D.C., manager of the *NERVA* and *SNAP-8* programs.

Paul D. Rodgers: Appointed as associate director of the tracking and instrumentation laboratory of the Astrionics Center, ITT Federal Laboratories, San Fernando, Calif.

Harvey B. Merrill, Jr.: Appointed product manager for scientific instruments at Acton Laboratories, Inc., Acton, Mass

John Carge: Promoted to manager of technical services for the Brush Instruments Div. of Clevite Corp., Cleveland.

Robert A. Manogue: Appointed director of sales for the Denison Engineering Div of the American Brake Shoe Co., Columbus, Ohio. **Robert Smilges** named director of engineering.

George D. Prestwich: Named manager of General Electric Co.'s Aerospace and Defense Marketing Operation, Washington, D.C.

Frank Bravenec: Appointed vice president of engineering at Houston Instrument Corp., Houston.

Robert Lord: Appointed computer research manager for the Berkeley Div. of Beckman Instruments, Inc., Richmond, Calif.

Byron Mable: Appointed chief development engineer for Ceramics International Corp., Mahwah, N.J.

Eugene Jonas: Appointed vice president of finance for Paradynamics, Inc., Huntington Station, N.Y.

T. Richard Harrington: Appointed sales engineer-western region for the refractory Metal Div., of Climax Molybdenum Co., Detroit.

E. Hugh Jones: Named general manager of Micromatic Hone Corp., Detriot

James T. Dunn: Appointed product sales manager for Chicago Bridge & Iron Co., Oak Brook, Ill.

Dr. John A. Rottenberg: Appointed staff scientist at Aerospace Research, Inc., Boston.

Clark Hickerson: Appointed director of customer requirements and contracts at Air Logistics Corp., Pasadena, Calif.

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—when and where—

DECEMBER

American Astronomical Society Annual Meeting, College, Alaska, Dec. 26-28.

Third Western National Meeting, Space and Planetary Sciences, sponsored by the American Geophysical Union, Boulder, Colo., Dec. 26-28.

American Association for the Advancement of Science 130th Annual Meeting, Sheraton Cleveland Hotel, Cleveland, Dec. 26-30.

Society for the History of Technology Annual Meeting, New York City, Dec. 26-30.

JANUARY

Institute of Physics and the Physical Society Conference on Solid-State Physics, University of Bristol, Bristol, England, Jan. 1-4.

10th National Symposium on Reliability and Quality Control, Statler Hilton Hotel, Washington, D.C., Jan. 7-9.

National Society of Professional Engineers Winter Meeting, Westward Ho Motel, Phoenix, Ariz., Jan. 8-11.

1964 Annual Automotive Engineering Congress and Exposition, Cobo Hall, Detroit, Jan. 12-17.

146th National Meeting of the American Chemical Society, Denver, Jan. 19-24.

Aerospace Sciences Meeting, Hotel Astor, New York City, Jan. 20-22.

American Physical Society Conference on Semimetals, Columbia University, New York City, Jan. 21.

American Physical Society Meeting, Statler Hilton Hotel, New York City, Jan. 22-25.

American Mathematical Society 70th Annual Meeting, Miami, Jan. 23-27.

Second Annual Symposium on Fundamental Phenomena in the Materials Sciences, Sheraton Plaza Hotel, Boston, Jan. 27-28.

Conference on Control and System Optimization, Naval Post Graduate School, Monterey, Calif., Jan. 27-29.

AIAA Solid Propellant Rocket Conference, Palo Alto, Calif., Jan. 29-31. (semi-classified).

American Meteorological Society 44th Annual Meeting, University of California at Los Angeles, Jan. 29-31.

FEBRUARY

American Institute of Chemical Engineers 52nd National Meeting, Hotel Peabody, Memphis, Tenn., Feb. 2-5.

IEEE Winter Power Meeting, Statler Hilton Hotel, New York City, Feb. 2-7.

International Congress on Documentation and Scientific-Technical Information, Rome, Feb. 2-11.

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Letter From the Editor

THE YEAR OF 1963 will be recorded as one of significant accomplishment by the missile/space industry. But it seemed to us, as we reviewed the past 12 months for this final 1963 editorial, that the most significant event in the industry itself was a decision made in the closing days of the year.

We are referring, of course, to the Administration go-ahead for a manned military space program to be built around the McDonnell *Gemini* capsule and the Martin *Titan III*. What the future will hold for the military in space only the future can reveal. But the start was made in this year of 1963.

The long years of arguing for a manned military space role have come to a close. The opportunity to prove that such a mission is vital and necessary is to be given. There undoubtedly will be future disputes about the size and nature of the military man's activities in space. But a beginning has been made. As the passage of years places the events of 1963 in perspective, we believe this will emerge as the most important single industry development of this year.

As we predicted at this time last year, the year was not one of frequent and impressive space triumphs but rather one of more mundane work in laying the foundations for the future. The long drought between the last *Mercury* flight and the first manned *Gemini* launch continues.

The year of 1964 will be even less eventful in the field of manned space flight by the U.S., although a more active unmanned schedule lies ahead.

But the spectacular 22-orbit flight of astronaut Gordon Cooper on May 15-16 was a worthy finale to the highly successful *Mercury* program. More limited in scope than its Soviet counterpart, *Mercury* exceeded expectations and proved that the U.S. is indeed a contestant in the technological competition with the Soviet Union. Despite such Soviet space spectaculars as the three- and five-day flights of the *Vostoks* which landed on June 19, the space gap seemed to yawn less widely as 1963 drew to a close.

The fact that much of the same team is now at work on the *Gemini* program offers hope that the work to be done in 1964 will result in an even more dramatic cut in the Russian space lead during 1965. But we should not delude ourselves that the Soviets are standing still in technical development. As Dr. Wernher von Braun pointed out at the ceremonies marking delivery of the first Chrysler-built *Saturn* to NASA, any belief that the Soviet Union is not pressing ahead with the development of larger boosters is pure foolishness. The Russians will establish that fact during 1964.

Any gain, any narrowing of the gap, will be due not to slackening of effort on the part of the Soviet Union but to an increasingly effective U.S. effort.

An election year lies ahead. The temptation to slash budgets in an effort to impress the voters is a tremendous one. Congress must prove itself worthy of resisting that temptation. And the citizenry must prove itself aware of the importance of the space effort by providing the necessary support for such resistance. IF this can be done—and once again it must be said that the year will not be one of headline-provoking manned launches from the Cape—then the U.S. in the year ahead will proceed with the foundation-laying for truly remarkable accomplishments before the end of this decade. President Johnson has said, "Let us continue," and so we must.

Delay, for both technical and financial reasons, manifested itself in the past 12 months in several programs. Project *Rover*, the nuclear rocket program, is confronted with a slippage of 16 months and is in deep difficulty. A decision as to the future of this project must be made soon, and is already under Administration study at the highest levels. The first manned *Apollo* flight has slipped nine months as a result of NASA's decision to drop from the program manned flights with *Saturn I*. The M-1 engine program has been slipped and *Titan II* has been plagued by a vibration problem.

But technical difficulty does not necessarily mean a dark future. In our annual review on this page at the end of last year, we noted that three programs were having technical troubles: *Skybolt, Polaris A3* and *Centaur*. The axe fell quickly on *Skybolt*. But *Centaur* received its DX priority early in the year and proved what can be done by a determined project team when it chalked up an almost entirely successful launch on November 27. The excellent *Polaris* team took the *A3* troubles in stride and brought it in on schedule.

The impact of Secretary of Defense McNamara's reorganization of the Pentagon began to be felt strongly in this past year. The long-needed overhaul of procedures in the Potomac puzzle palace met with general industry approval, although there are still some reservations about its effect on weapon systems of the future. These may be resolved in 1964.

Under pressure from Congress, the Pentagon agreed to substantial funding for big solid booster development in Fiscal 1964 and 1965. This programming called for expenditure of $54 million in the big-solids field in FY '65 and, if this withstands the current economy wave, significant achievement in big solids should be demonstrated in 1964. A step in this direction was taken on July 20 with United Technology's firing of the 120-in. prototype segmented booster for the *Titan III-C*.

One of the most impressive accomplishments of 1963 took place with the successful orbiting of the Hughes *Syncom II* on July 26, opening the door to a new communications era.

In the missile field, the future of the *Mobile Medium Range Ballistic Missile* continued uncertain, but Martin's *Pershing* moved smoothly toward operational status and the Navy took the wraps off Goodyear's *Subroc* after a highly successful test program.

The industry lost its elder statesman in 1963 with the death of Dr. Theodore von Karman on May 7, shortly before his 82nd birthday. And the industry, with the nation, mourned the loss of a President.

IT IS WITH sober reflection on the meaning of all these events, on the sad days and the happier ones, that we at MISSILES AND ROCKETS wish you a peaceful and productive New Year. And, of course, a wonderful Christmas.

William J. Coughlin

HUNTSVILLE, ALABAMA...SATURN I BOOSTER IS CAPTIVE-FIRED IN FINAL PREPARATION FOR LAUNCHING. EIGHT H-I ENGINES OF THE FIRST STAGE DEVELOP 1.5 MILLION POUNDS OF THRUST NEEDED TO TEST APOLLO SPACE CRAFT AS PART OF THE UNITED STATES MANNED LUNAR PROGRAM. BEHIND THE SCENES, VITRO SERVICES PROVIDES MAJOR TECHNICAL SUPPORT FOR NASA TEST DIVISION LOCATED AT THE GEORGE C. MARSHALL SPACE FLIGHT CENTER HERE.

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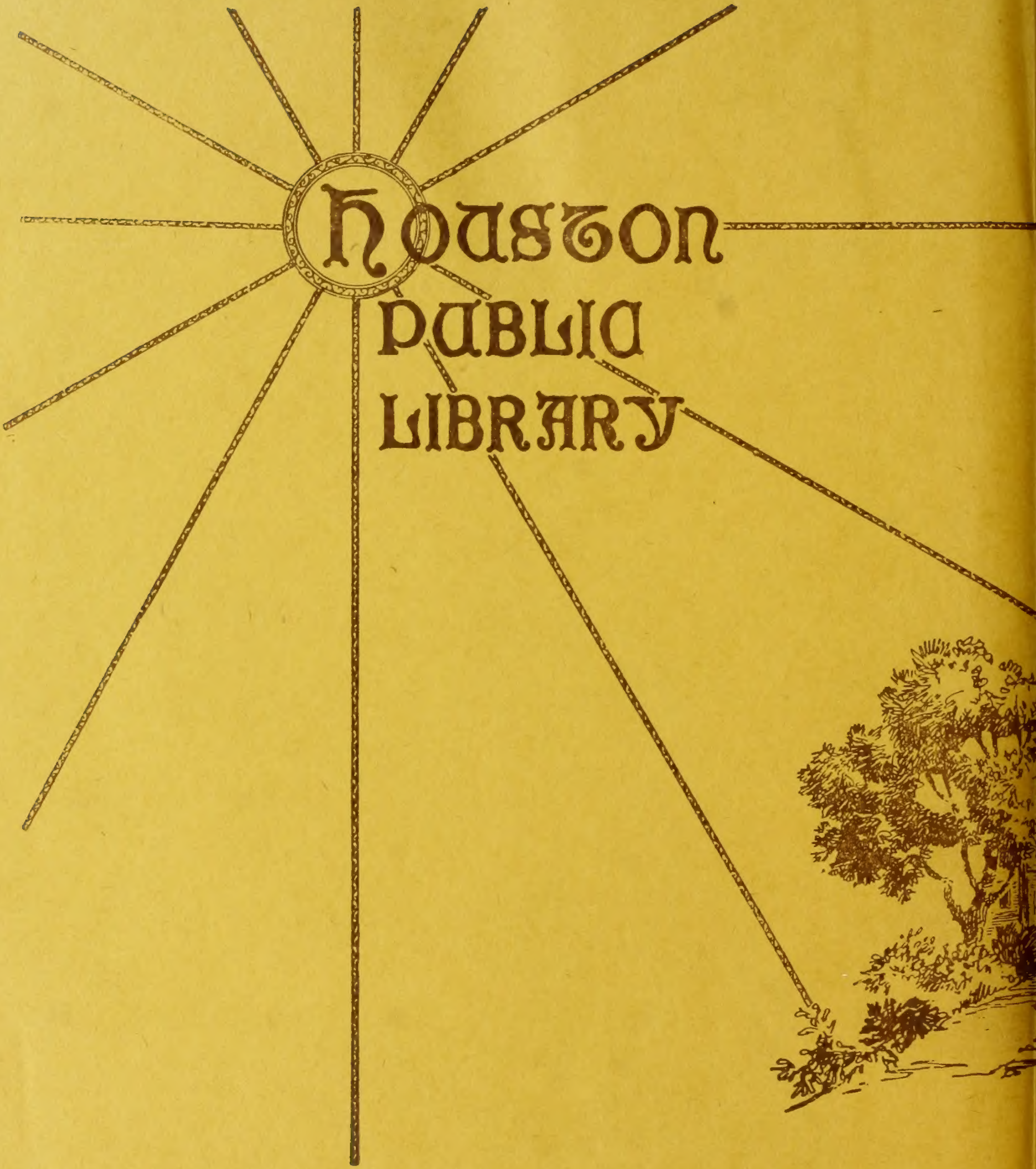

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